FEDERATE

Software-Defined Vehicle Support and Coordination Project

D5.4 SDV open source progress report

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1 Executive Summary

This deliverable provides a comprehensive overview of stakeholder engagement and contributions within the Software-Defined Vehicle (SDV) ecosystem under the FEDERATE project, its associated EU-funded projects, and open source initiatives.

1.1 Purpose and Scope

Taking a 'code-first' approach, this report focuses on analysing stakeholder participation metrics, cataloguing building blocks, and emphasising the growing importance of open collaboration in advancing SDV technologies. It illustrates how FEDERATE and related initiatives – including HAL4SDV, SHIFT2SDV, and the Eclipse SDV Working Group – are fostering open collaboration across the European automotive software landscape. This collaborative approach accelerates innovation, promotes the reuse of non-differentiating features, and reinforces the EU's leadership in SDV technologies.

1.2 Key Findings

Building blocks

- As of the end of July, FEDERATE has curated **178 building blocks** in various SDV-related domains.
- **Over 94%** of these building blocks are hosted by the Eclipse Foundation, underpinning the central role of open source governance.
- The building blocks span a wide range of tools – from in-vehicle engineering and support tools and middleware to support technologies such as IDEs and debugging tools and cloud stack components.

EU-funded projects

- **HAL4SDV delivers an open hardware abstraction layer** enabling hardware-independent deployment. Its first year already yielded contributions to Eclipse projects such as Eclipse Kuksa, Eclipse uProtocol, Eclipse S-CORE, Eclipse Autowrx, Eclipse OpenDUT, and Eclipse Papyrus. It also actively contributes to the COVESA Vehicle Signal Specification (VSS).
- **SHIFT2SDV**, launched in July 2025, aims to develop a **common, hardware-independent, and language-agnostic middleware framework** to facilitate the development of automotive applications using microservices and to support the gradual shift from monolithic vehicle software to a more modular architecture.

Open source initiatives: Eclipse SDV Working Group

- **Number of open/closed issues**: A 78.9% growth rate indicates increased problem-solving and task management.
- **Number of commits:** Grew by 51.8%, with more than 14,900 commits in year two, showing accelerating technical and scientific progress.
- **Number of pull or merge requests:** Increased by 86.8% year-over-year. The number of contributors (submitters) grew by 96 (a 34.8% increase), and the number of repositories increased by 43 (34.4% increase). This substantial increase across all metrics demonstrates expansion of the project's development activity and community engagement.
- **Unique code contributors:** The number of unique authors increased by 83, representing a growth of approximately 28.1% year-over-year.

- **Forks over time:** Forks of the top 10 repositories show a significant increase in interest in these open source projects, with the Eclipse eCAL repository leading the charge.

1.3 Impact

The findings confirm that FEDERATE serves as a catalyst and thought leader for open source SDV development in Europe. By aligning efforts across initiatives and consolidating contributions under the umbrella of the Eclipse Foundation, FEDERATE has strengthened both technical progress and community participation, paving the way for:

- Accelerated innovation in the field of SDVs
- Stronger integration and interoperability
- Broader adoption of open standards
- A sustainable developer ecosystem

The increase in open source activities in the reporting years was supported by the public relations work within the framework of FEDERATE. For details, please refer to the event overview in WP5.

2 Introduction

2.1 Introduction – Purpose of This Document

The scope of this deliverable is to highlight the growing momentum and contribution to OS SW – following the code-first mantra – due to work done within the FEDERATE project and the implementation projects such as HAL4SDV and SHIFT2SDV. The awareness has shifted towards collaboration in the open and work on non-differentiating features to speed up development and secure EU leadership.

As a CSA, FEDERATE is a non-implementation project, hence this report relies on metrics and work done in the framework of other projects, particularly HAL4SDV which just passed its first year review and SHIFT2SDV that has just started operations.

This report utilizes the Building Blocks collection from WP2 and WP3 to gather statistics on the SW components mentioned within those collections. We analyze the following metrics to evaluate stakeholder participation in OS SW projects, comparing data across successive years:

- **Number of open/closed issues:** This indicates user feedback, suggested improvements, and the project team's responsiveness and efficiency in addressing them.
- **Number of commits:** This reflects the pace and volume of ongoing development activity, indicating the project's vitality and sustained technical progress.
- **Number of pull requests (or merge requests) opened/merged:** This measures active development and collaboration, including external and internal developer contributions and the project's capacity to integrate these contributions.
- **Unique code contributors:** This signifies the growth and health of the developer community, indicating a broader and more diverse developer base.
- **Forks over time:** This reflects active engagement and interest in working with the codebase, whether for personal learning, internal development, or community contribution.

2.2 Definitions

Table 1: Definitions, Acronyms, Abbreviations

Definitions, Acronyms, Abbreviations	Meaning
SDV	Software Defined Vehicle
HAL4SDV	Hardware Abstraction Layer for SDV
SHIFT2SDV	Smart, Heterogeneous, Integrated, Flexible, and Tailored SDV
BB	Building Block
OS	Open Source
SW	Software
WP	Work Package

2.3 Document Structure

This document is structured as follows: we articulate the work done in collecting building blocks in the framework of the FEDERATE project, and list the contribution of HAL4SDV and SHIFT2SDV. With a focus on projects under the purview of the Eclipse SDV Working Group, we gather and analyze objective metrics that indicate growth and maturity of the open source community.

3 Contribution to Open-Source Software Projects

3.1 FEDERATE's Collection of Building Blocks

The FEDERATE initiative has undertaken the initiative of collecting building blocks as an open repository on GitLab that can be accessed here: https://github.com/CSA-FEDERATE/Proposed-BuildingBlocks.
This initiative defines reusable software components for SDVs, covering in-vehicle, cloud, toolchain, and support layers. It includes mature and draft contributions structured by function, such as stack components, engineering tools, and supporting APIs. The focus is on interoperability, modularity, and openness, enabling cross-project and cross-domain integration. A strong majority of blocks are aligned with the Eclipse ecosystem, reinforcing open-source collaboration. The collection serves as a reference model to guide architecture, implementation, and standardization in EU-funded SDV initiatives.
Please refer to WP3 in the BB Repository in FEDERATE.

As of the end of July the repository hosted by the FEDERATE CSA GitLab instance, counts a considerable number of building blocks, most of which (more than 90%) are hosted by the Eclipse Foundation, as hence are open source contributions. Particularly notable are the categories: Stack Components (In-Vehicle), Cloud Engineering & Support Tools, Cloud Engineering & Support Tools.

Description	Category	Count	Hosted by Eclipse (%)
In-Progress or draft blocks across all domains	`WorkInProgress/`	87	98.9% (86/87)
Stack Components (In-Vehicle) – middleware, IPC, OS abstractions	`BB-SC/`	40	97.5% (39/40)
Cloud Engineering & Support Tools (e.g. CI/CD, dashboards, logs)	`BB-CEST/`	15	100% (15/15)
Supporting Building Blocks – vocabularies, data models, system APIs	`S-BB/`	13	100% (13/13)
In-Vehicle Engineering & Support Tools – IDEs, debugging, analysis	`BB-EST/`	11	100% (11/11)
Miscellaneous or unclassified (potential stubs, shared notes, templates)	`other/`	6	16.7% (1/6)
Cloud Mock-Up Units – cloud-based testbeds or emulations	`BB-CMU/`	1	0% (0/1)

Toolchain for Cloud Stack – dev pipelines, automation	BB-CSC-TC/	1	100% (1/1)
Cloud Stack Components – e.g., microservices, runtime components	BB-CSC/	1	0% (0/1)
In-Vehicle Mock-Up Units – HIL/SIL, testing rigs	BB-MU/	1	0% (0/1)
Toolchain for In-Vehicle Stack – build/integration tooling	BB-SC-TC/	1	0% (0/1)
Use Case definitions or drivers	UseCases/	1	0% (0/1)

Total Summary
Total BBs: 178
Eclipse Hosting Coverage: ~94% of all contributions

The building block collection work performed in WP2 and WP3 demonstrates a profound and extensive integration with the Eclipse ecosystem, a strategic choice that underpins its commitment to open governance and collaborative development.

Specifically, the project heavily references and builds upon a diverse array of established Eclipse Foundation projects. These include, but are not limited to:

- Eclipse Kuksa: A foundational project for secure and scalable data exchange in automotive and mobility applications, critical for connecting vehicles to the cloud and enabling new services.
- Eclipse CycloneDDS: A high-performance, real-time publish-subscribe framework based on the Data Distribution Service (DDS) standard, essential for robust communication in complex distributed systems.
- Eclipse SUMO: A widely used open-source traffic simulation package, vital for testing and validating automotive software and intelligent transportation systems in a virtual environment.
- OpenADx: A collaborative initiative focused on creating an open and interoperable platform for automated driving development, promoting standardization and accelerating innovation in this rapidly evolving field.
- Eclipse iceoryx: A high-performance inter-process communication (IPC) framework optimized for real-time and safety-critical applications, ensuring efficient data transfer within complex embedded systems.

3.2 EU-Funded Projects

Among the EU funded projects that endeavour to develop building blocks for in an Open Source environment are HAL4SDV and SHIFT2SDV.

HAL4SDV focuses on creating an open, standardized Hardware Abstraction Layer that decouples software from specific vehicle hardware. In this context, the main goal of HAL4SDV is providing reference implementations and validation in real vehicle environments that enable hardware-independent software deployment across vehicle platforms.

SHIFT2SDV leverages HAL4SDV and has a broader architectural scope focused on the entire SDV software stack, aiming to define a reference architecture for modular, cross-domain SDV software, and to harmonize software development and integration processes across OEMs and suppliers.

Together, HAL4SDV and SHIFT2SDV complement each other by addressing the foundational hardware abstraction layer (HAL4SDV) and the overarching system architecture and toolchain (SHIFT2SDV) needed to realize scalable, open, and interoperable SDVs in Europe.

HAL4SDV has recently seen its first year review, while SHIFT2SDV its kick-off meeting. This report focuses on the results obtained in HAL4SDV during its first year of operation, and the proposal of SHIFT2SDV.

3.2.1 HAL4SDV Open-Source Contributions

HAL4SDV actively contributes to several Eclipse Foundation projects, including:

- Eclipse KUKSA: A foundational project for secure and scalable data exchange in automotive and mobility applications, critical for connecting vehicles to the cloud and enabling new services.
- Eclipse u-Protocol: Eclipse hosts a variety of open-source projects in Communication Middleware, with Eclipse uProtocol being one of the most mature. It functions as a communication framework, connecting several communication protocols like Some/IP, CAN, and Eclipse Zenoh
- Eclipse S-CORE: This project, also known as Eclipse Safe Open Vehicle Core, targets an Open-Source safety-relevant vehicle central architecture-based approach for an SDV core stack suitable for high-performance computing ECUs. The S-CORE stack aims to close the gap between the hardware abstraction layer and the API towards vehicle function application. A proposal for joining forces between HAL4SDV, S-CORE, and Shift2SDV was initiated, with a target first meeting planned for Q2/2025.
- Eclipse Autowrx: this project is the open-source implementation of digital.auto, an industry-wide initiative focused on establishing a digital-first approach for creating next-generation customer experiences and data-driven mobility services in the automotive industry. It provides an in-browser, rapid prototyping and collaboration platform for connected vehicles, utilizing standardized vehicle APIs and supporting the development of software-defined vehicles.
- Eclipse OpenDUT: this project is a testing framework for developing and running hardware-in-the-loop (HIL) tests for embedded systems, particularly within the automotive domain. It provides a standardized and extensible platform for automating the testing of devices under test (DUTs) and integrates with various hardware and software tools.
- Eclipse Papyrus:
- Eclipse SDV Key Value Store
- CARISMA – Car integrated service mesh architecture - to be contributed to Eclipse

HAL4SDV also contributes actively to COVESA, particularly to Vehicle Signal Specification – VSS. This is an open data model designed to create a common language for vehicle data, like speed or tire pressure, making it consistent across different manufacturers. This standardization helps developers build applications that can work with a wide range of vehicles, promoting innovation and interoperability in the automotive industry.

Detailed contributions

The list below represents a detailed OS contribution per partner. The activities are carried out within WP 3 Simulation & Modelling of SDV Platform, Modules & MW/SW Components, and the Transversal Activities TA-BB-A HW/SW Abstraction and TA-BB B APIs & Interfaces

Partner	OS Contribution
MBAG, BOSCH, Steinbeis digital.auto	Mix&Match Framework for mixed virtual / target HW test scenarios, utilizing COVESA VSS and the distributed testing network OpenDuT. Eclipse digital.auto Blueprint for managing SDV staging from virtual development to target HW, utilizing Eclipse autowrx, Eclipse OpenDuT, Eclipse Velocitas, COVESA VSS
MBAG	CARISMA: Car-Integrated Service Mesh. Bringing Service Mesh into in-vehicle architectures.
MBAG	Eclipse OpenDuT Open1722 extension: This building block offers an extension of the Eclipse OpenDuT testing framework by the IEEE1722 protocol to make communication between ECUs more efficient.
TUM	Tool that leverages model-based representations in synergy with LLMs for generating code covering various aspects: communication middleware, deployment configuration and simulation tests for vehicle digital twin and virtual ECU platform
ZF	Open VehicleAPI Framework: The VAPI is an open component based framework in C++ for setting up and using a vehicle abstraction through multiple abstraction stages (VAPI Layers).Built VAPI Component s don't rely on exact matching of compiler versions for compatibility, even multiple different compilers can be used to create a set of components that work together, The VAPI is designed to be used event-driven, but can work in a timed context using Platform Abstraction functionalities. VAPI framework supports Mixed criticality functions.
NXP-NL	Development of the open-source example integrating DDS with TSN Ethernet protocols to enable deterministic communication in safety-critical systems.
USTUTT	Plug-and-Play Sensors with Asset Administration Shell: This work demonstrates how the Asset Administration Shell (AAS) can serve as a vendor-neutral, lifecycle-robust abstraction layer for heterogeneous sensors in software-defined vehicles by combining Eclipse BaSyx with COVESA VSS for standardized signal mapping. The implementation with our ROS-based UGV is aimed at demonstrating plug-and-play interoperability through automated onboarding, validation of sensors on the fly.
VIF	VSS Extension for in Vehicle Hardware Platform System States: This OSS contribution will provide an extension aligned with the VSS (overlay). This extension provides information about the system state of HPC hardware

	platforms such as AvgCPUCoreUtilisation, CPUCoreOverload, etc., as well as corresponding additional performance measurements for RAM, NetworkUtilisation, etc.
TU/e	TSN simulation and optimization framework - A framework for simulating, analyzing, and optimising TSN configurations

Contributions from TA-BB F Integration, Testing, Simulation, Tools

In TA-BB-F activity in the HAL4SDV project as of today, following open-source contributions are planned:

- LLM-based code optimizer: Based on timing analysis and goals defined as freeform text, this tool can improve the existing code in order to meet the timing demands (TUM, StatInf)
- LLM-based code generator: Tool that leverages model-based representations in synergy with LLMs for generating code covering various aspects: communication middleware, deployment configuration and simulation tests for vehicle digital twin and virtual ECU platform (TUM, Continental, CSIC)
- OpenDuT Extension - COVESA VSS: Adding the possibility to use COVESA VSS based test execution scripts to ease test development. (MBAG, Bosch)

However, for other contributions it was not yet decided if the implementations will be made open-source.

3.2.2 SHIFT2SDV – Planned Open-Source Contributions

SHIFT2SDV is a European research and innovation project focused on creating a Software-Defined Vehicle (SDV) ecosystem. The project aims to develop a common, hardware-independent, and language-agnostic middleware framework. This framework is designed to facilitate the development of automotive applications using micro-services and to support the gradual shift from monolithic vehicle software to a more modular architecture.
The project has had its kickoff meeting in July, and is planning to deliver the following contributions.

Planned Contributions

The project's key planned contributions to open source center on its core objectives, which include:

- **Middleware Framework**: SHIFT2SDV intends to contribute a new middleware framework that provides micro-services for building automotive applications. This framework will abstract away the underlying hardware, allowing for more flexible and rapid development.
- **APIs and Software Development Solutions:** The project will also contribute APIs and various software development solutions to foster collaboration across the automotive value chain. These contributions are intended to simplify the development and integration of software, ensuring compatibility and flexibility with existing and new technologies.
- **Orchestration and Resource Management:** A central part of SHIFT2SDV's open-source effort is to develop an orchestration system for efficient resource management within the vehicle's software architecture. This will include integrating edge and cloud computing capabilities.

By focusing on a modular, micro-services-based architecture and providing open-source tools and frameworks, SHIFT2SDV aims to accelerate innovation in the European automotive industry and establish a foundation for next-generation automotive computing platforms.

As the project has just been started in July 2025, Shift2SDV partners and Building Blocks are currently identifying their possible contributions (what/where/when/how/who/…). Open-Source contributions are targeted by the following Building Blocks:

- A1: Sensor API
- B1: Motion APIs and Application Software
- C1: Plug & Charge
- D1: Multimedia API
- E1: In-Vehicle Communication Middleware
- E2: V2X Communication Middleware
- F1: Intrusion detection
- F2: Anomaly detection
- F3: Security and Safety API
- G1: Digital twin for vECU
- H1: SOVD
- I1: Microservice management
- I2: SDK - Lib & variant management
- J1: SDK - Data centric access

3.3 Open Source Projects

3.2.1 Analysis of Metrics from Open-Source Projects under the Eclipse SDV Working Group Purview

In the context of open source software (OSS), engagement extends far beyond mere passive usage or download counts. It encompasses a multifaceted array of activities that reflect active participation, collaborative contribution, and robust community building. This includes, but is not limited to, direct contributions to the codebase through pull requests, reporting and managing issues, enhancing documentation, participating in community forums and discussions, providing user support, and advocating for the project. The open source development model fundamentally relies on transparency and collaboration, which are core benefits of such projects. Therefore, a comprehensive assessment of engagement must capture the vibrancy and health of this collaborative environment.

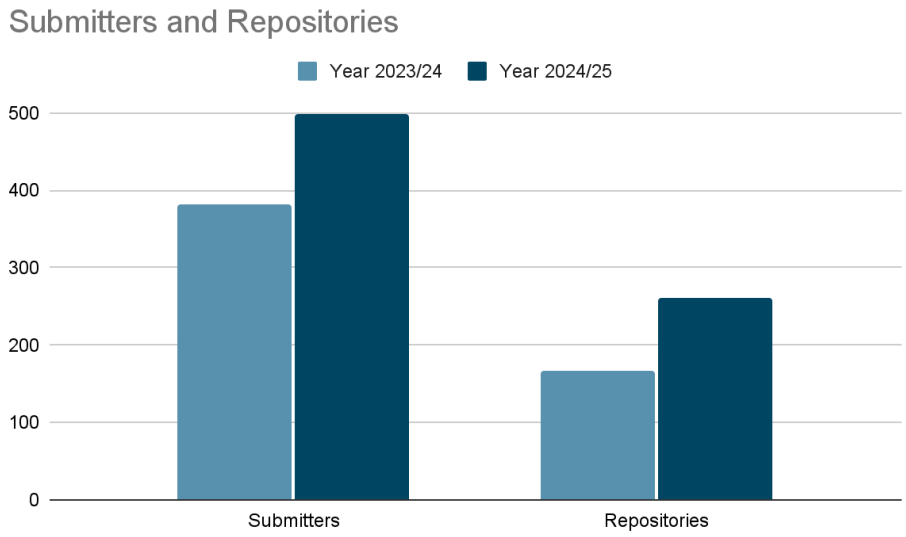
To effectively measure engagement, this analysis adopted a balanced set of metrics that capture quantitative activity and qualitative community health, in order to provide direct evidence of technical development and collaborative involvement within the project.

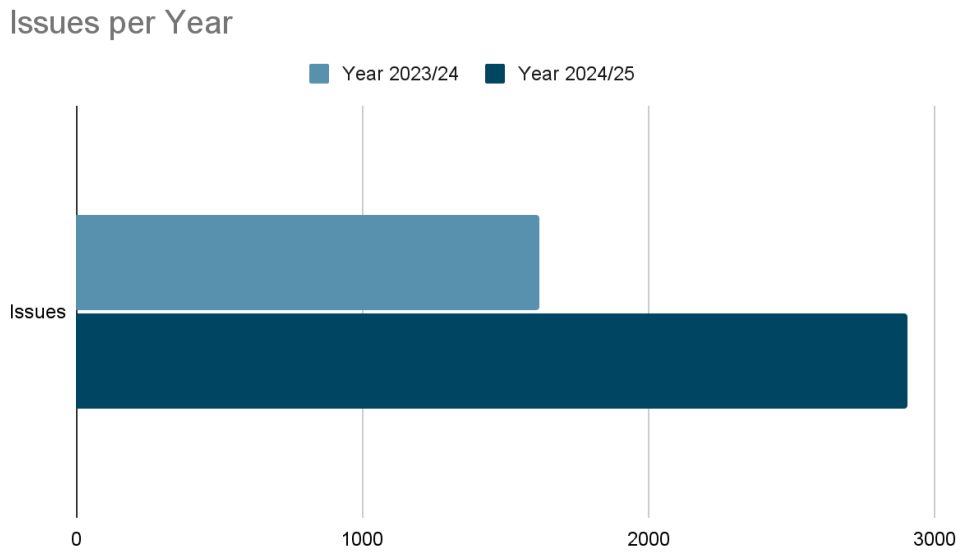
The graphs present comparisons of two consecutive years (01.03.2023 to 28.02.2024; and 01.03.2024 to 28.02.2025) all projects mentioned in the FEDERATE Building Block collection that are hosted by the Eclipse Foundation. HAL4SDV started in April 2024 so we expect the contributions to open-source to be increased in the second year. We believe that the statistics gathered are significant as the Eclipse Foundation hosts more than 90% of the projects.

Number of open/closed issues

This includes the Number of opened and closed issues, and the number of submitters and repositories. Issues typically represent bug reports, feature requests, or points of discussion. Tracking them indicates user feedback and the project team's responsiveness. For the FEDERATE project, this shows user engagement in

identifying problems or suggesting improvements, as well as the project team's efficiency in addressing them.



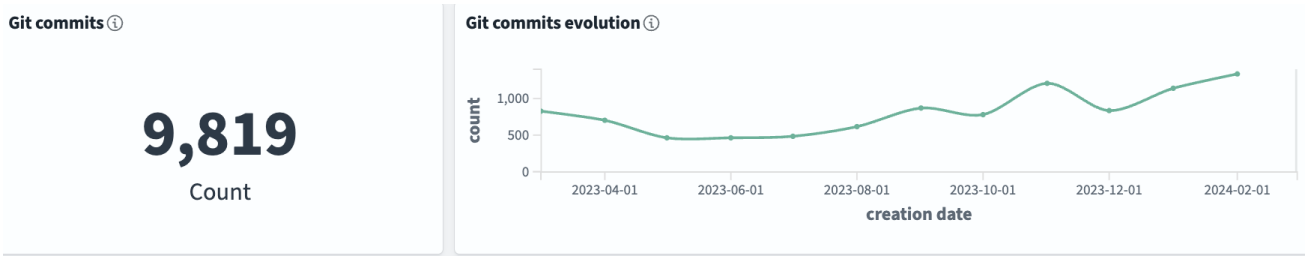


In summary, the project demonstrated significant growth across all three metrics. The substantial increases in issues, submitters, and repositories provide strong evidence of an expanding project scope, a larger and more engaged community, and a significant acceleration of development activity. The highest growth rate was observed in the number of issues (78.9%), indicating increased problem-solving and task management, followed by repositories (55.6%), suggesting a broader base for project components.

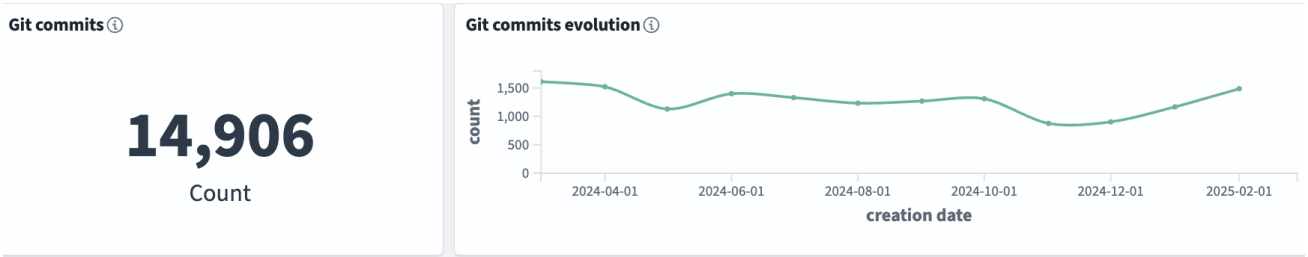
Number of commits

The metric showing average commits per designated period reflects the pace and volume of ongoing development activity. Consistent commit activity indicates the project's vitality and provides ample opportunities for external engagement and contribution. A steady commit frequency, such as 50+ commits per week, provides evidence of sustained scientific and technical progress.

Below is the representation of the number of commits and their evolution over time for the timeframe 01.03.2023 to 28.02.2024; i.e. a period of one year after the Federate project started:



Additionally, the number of commits and their evolution over time for the timeframe 01.03.2024 to 28.02.2025, i.e. two years into the Federate project.

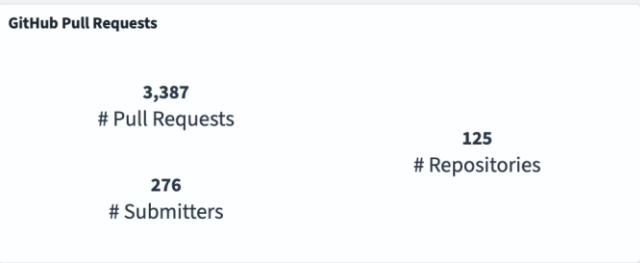


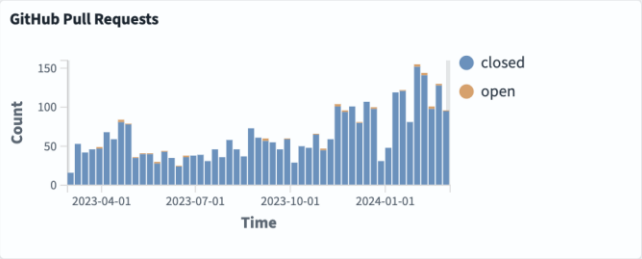
In summary, the project demonstrated significant growth in development activity. The number of commits increased by 5,087 from the first year (9,819 commits) to the second year (14,906 commits), representing a growth of approximately 51.8%. This substantial increase in commits provides concrete evidence of an acceleration in technical and scientific progress following the project's initial phase.

Number of pull requests (or merge requests) opened/merged

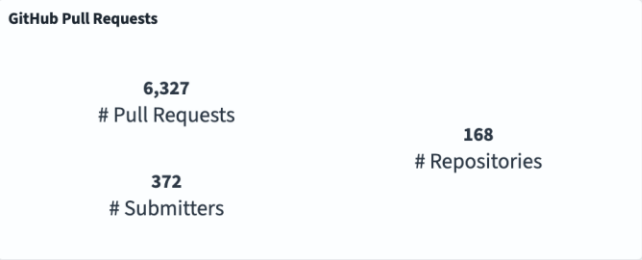
This category includes the number of opened pull requests, number of merged pull requests, and number of closed (unmerged) pull requests. Pull requests represent proposals for changes to the codebase, and tracking their lifecycle indicates active development and collaboration. For FEDERATE, this directly measures both external and internal developer contributions and the project's capacity to integrate these contributions. A high number of merged pull requests, for instance, signifies successful collaboration and effective code integration. Year-over-year we have seen an increase of merged pull requests by 86.8%, demonstrating industrial impact through active development and knowledge co-creation.

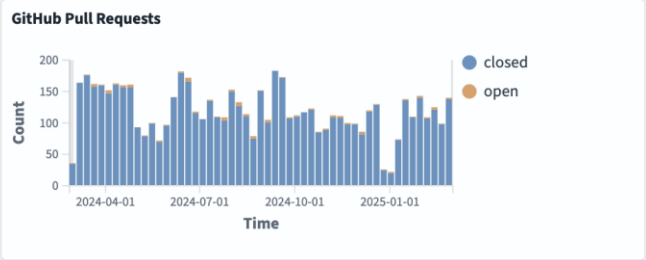
Below is the representation of the number of pull requests (open and closed), number of submitters and repositories for the year 1 after the project Federate started.





Additionally, below is the representation of the number of pull requests (open and closed), number of submitters and repositories for the second year of the project Federate.



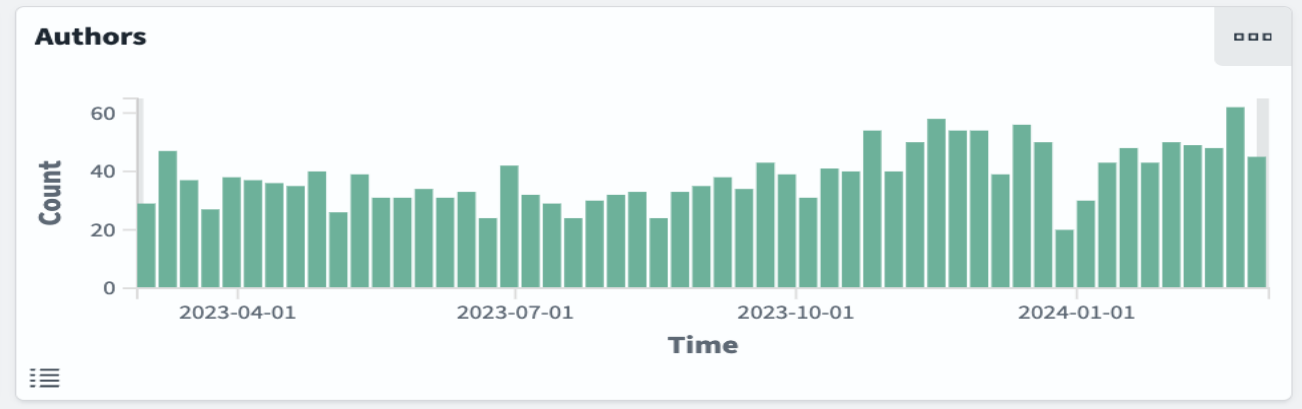


In summary, we saw an overall growth in all measured statistics. The total number of pull requests increased by 2,940, representing a growth of approximately 86.8% year-over-year. The number of contributors (submitters) grew by 96 (a 34.8% increase), and the number of repositories increased by 43 (34.4% increase). This substantial increase across all metrics demonstrates expansion of the project's development activity and community engagement.

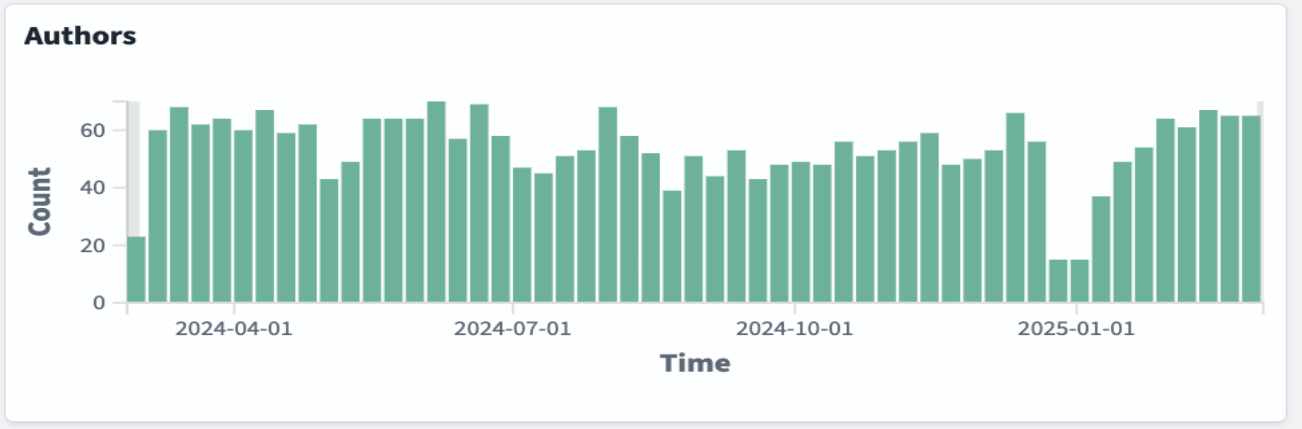
Unique code contributors

A "unique code contributor" is a distinct individual (usually identified by email or username) who has contributed at least once to the codebase within a given time period (e.g., per month). A steady increase indicates a growing and healthy developer community.

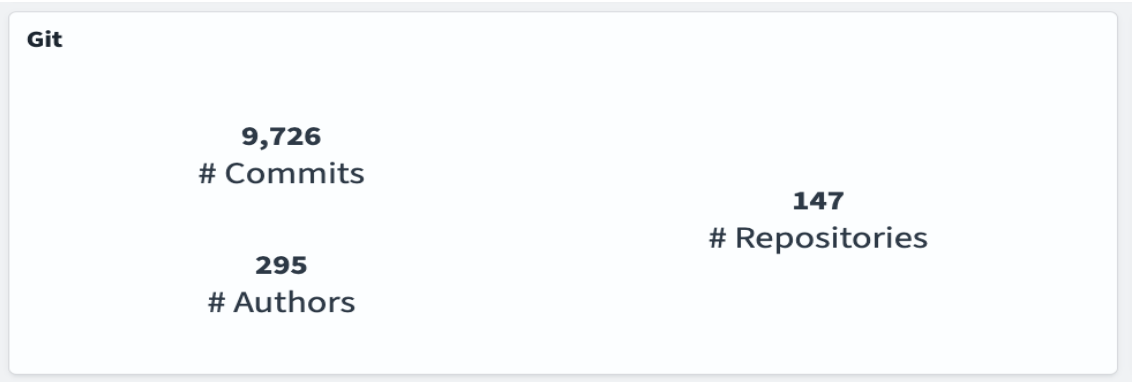
Below is the representation of the authors or unique code contributors, for the year 1 after the project Federate started.



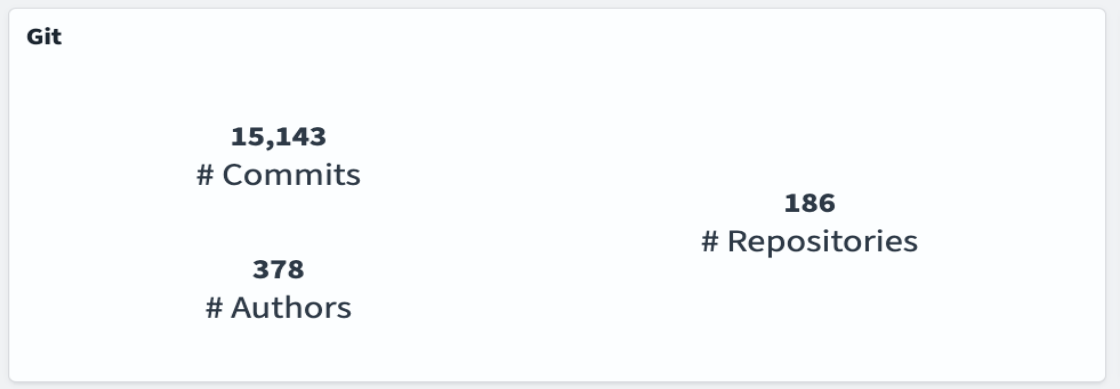
Additionally, the representation of the authors or unique code contributors for the second year of the project Federate.



Number of authors (01.03.2023 to 28.02.2024)



Number of authors (01.03.2024 to 28.02.2054)

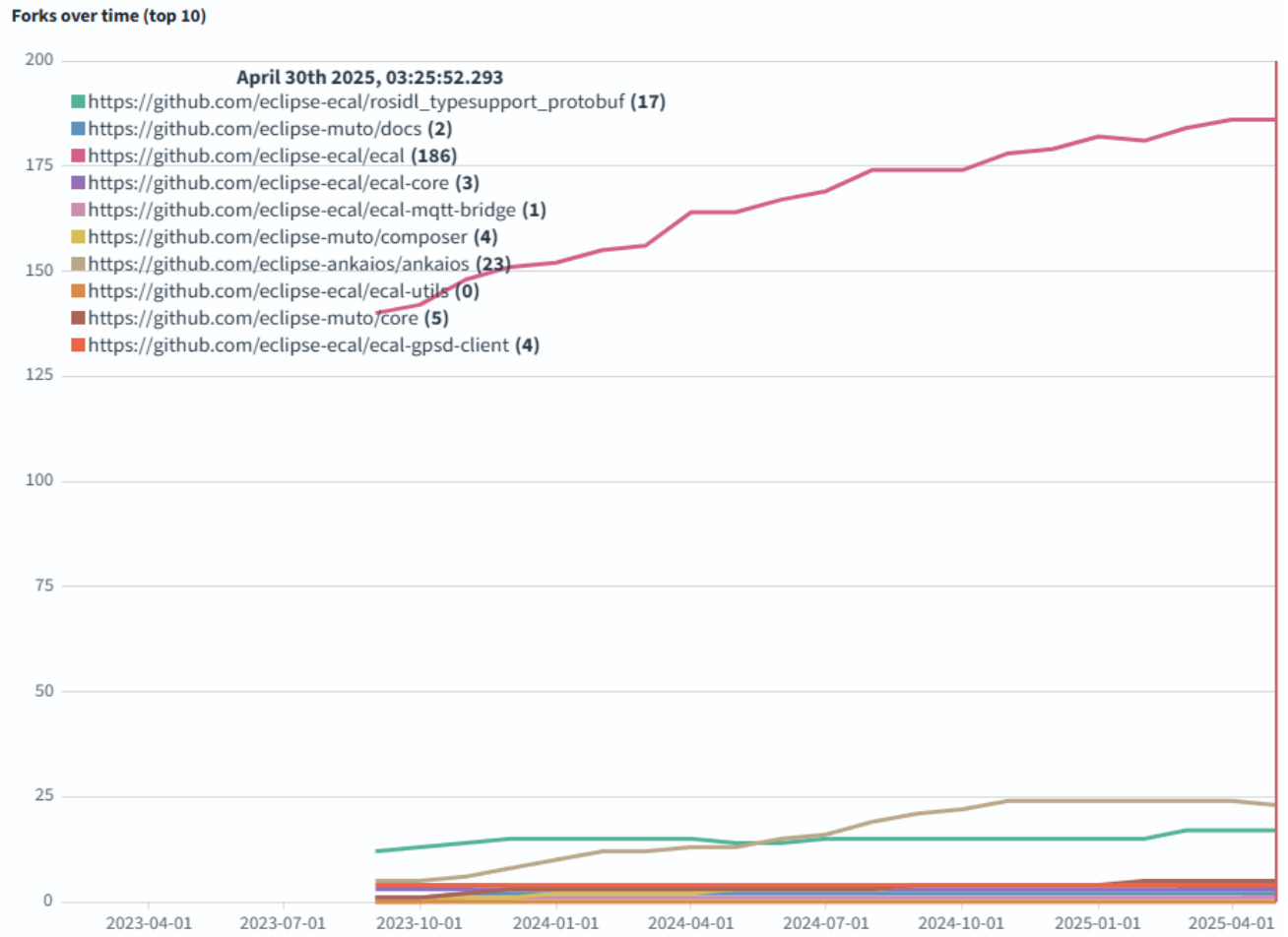


In summary, the project demonstrated a healthy and growing developer community. The number of unique authors increased by 83, representing a growth of approximately 28.1% year-over-year. This growth in the contributor base, coupled with a 55.7% increase in commits and a 26.5% increase in repositories, provides clear evidence of a significant expansion of the project's developer community and its overall development vitality.

Forks over time

Total Repository Forks refers to the number of times repositories under the SDV Working Group at the Eclipse Foundation have been forked by GitHub users. Each fork represents a user creating a personal copy of a repository. This is typically done to contribute changes via pull requests, to experiment independently, or to customize the code for private use. In contrast to stars, which signal passive interest, forks are a more active indicator of engagement. They reflect an intent to work with the codebase, whether for personal learning, internal development, or community contribution.

The cumulative line chart illustrates long-term interest and engagement in Eclipse Foundation projects. A steep slope as shown below, indicates growing attention. In conclusion, forks of repositories (Top 10) over time (01.09.2023 until 30.04.2025) show a significant increase in interest in these open source projects. This timeframe aligns with the kickoff and implementation of the FEDERATE project, during which this metric demonstrated a steady upward trend, indicating increased engagement with Eclipse Foundation projects.



The chart illustrates a steady and significant increase in the number of forks for the top 10 repositories. The most prominent growth is seen in the https://github.com/eclipse-ecal/ecal repository, which saw its fork count rise from approximately 150 to over 186 during this period. Other repositories also showed gradual increases in forks, indicating a growing and sustained interest in these projects.

3.2.2 Engagement Results Based on the Metrics Analysis

This analysis covers two consecutive years (01.03.2023–28.02.2024 and 01.03.2024–28.02.2025) across all projects mentioned in the FEDERATE Building Block collection, hosted by the Eclipse Foundation; with particular emphasis on the evolution and impact of the FEDERATE project.

The metrics present compelling evidence of growing community engagement, technical activity, and stakeholder participation across several dimensions:

- **Issue tracking** shows active user feedback and responsive project teams, reflecting a maturing feedback loop between users and developers.
- **Commit activity** has remained consistently strong, indicating sustained engineering velocity and an ongoing investment in feature delivery, maintenance, and experimentation.

- **Pull request dynamics**—with an increase in opened and merged pull requests—confirm growing collaboration both within core teams and from external contributors. This reflects successful knowledge transfer and integration.

- **Unique code contributors** increased steadily, pointing to the development of a broader and more diverse developer base, which is critical for long-term project sustainability.

- **Forks of repositories** show increasing external interest in Eclipse SDV projects. As more developers fork repositories, the potential for downstream adoption, customization, and contributions also grows.

Taken together, these metrics confirm a clear and measurable strengthening of the Eclipse SDV ecosystem. The FEDERATE project appears to have served as a catalyst—accelerating engagement, contribution rates, and technical evolution across affiliated projects.

This trend reflects more than project health—it demonstrates the strategic value of open collaboration, coordinated community engagement, and structured open-source governance. Eclipse is not only sustaining activity; it is growing a vibrant, active, and expanding developer community.

4. Conclusions

The analysis presented in this deliverable underscores the pivotal role of open collaboration in shaping the future of software-defined vehicles within Europe. By consolidating contributions across projects such as FEDERATE, HAL4SDV, SHIFT2SDV, and the Eclipse SDV Working Group, the report provides tangible evidence of both technical progress and community engagement. The metrics demonstrate a robust upward trajectory in stakeholder participation, with significant increases in code contributions, repository activity, and the number of unique contributors, all of which point to a thriving and sustainable ecosystem.

Beyond the quantitative indicators, the results highlight a cultural shift towards shared innovation and collective problem-solving, where non-differentiating features are openly developed for the benefit of the wider community. This collaborative ethos not only accelerates the pace of technological advancement but also reduces duplication of effort, fosters interoperability, and creates a solid foundation for industrial adoption.

The strategic importance of this movement cannot be overstated. By aligning European stakeholders under open governance models and widely adopted standards, the SDV ecosystem is reinforcing the region's position as a global leader in automotive software innovation. The synergies between foundational initiatives such as HAL4SDV, architectural frameworks like SHIFT2SDV, and the broader Eclipse-led community provide the critical mass needed to influence international practices, establish long-term sustainability, and drive global competitiveness.

In conclusion, FEDERATE has proven to be more than a coordination project: it has become a catalyst for change, inspiring greater levels of engagement, guiding the integration of building blocks across domains, and laying the groundwork for the next generation of open, interoperable, and modular SDV platforms. The continued momentum observed in this report suggests that Europe is well-placed not only to sustain this growth but also to set the benchmark for collaborative automotive software development worldwide.