European **Software-Defined Vehicle of the Future** (SDVoF) Initiative – Vision and Roadmap

Version: 17 |

The project has been accepted for funding within the Chips Joint Undertaking (CHIPS JU), a public-private partnership in collaboration with the Horizon Europe (HORIZON) Framework Programme under Grant Agreement No. 101139749

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Approved by the Sherpa Governance Group by written procedure on Apr 10th, 2024 |

Executive Summary

The European Commission's Directorate-General for Communications Networks, Content, and Technology initiated a consultation process in late 2022, leading to the establishment of the "**Software Defined Vehicle of the Future (SDVoF) initiative**". As the automotive industry shifts toward autonomous, electric, connected, and service-oriented vehicles, the significance of both hardware and software is growing. Software now drives value creation, serving functions and services both within vehicles (on-board) and in the cloud (off-board) as well as the infrastructure around the vehicle, which will provide mobility services. Customers prioritize "software freshness," seeking new applications and services related to infotainment, connectivity, and ADAS/AD functionality. Regular over-the-air updates enhance cyber-security, safety, and innovation during the vehicle's operational lifespan. This transition fuels demand for next-generation system-on-chip designs and high-performance processors, fundamentally reshaping software development and integration, and opens the opportunity to re-think and re-design the vehicle software stack to match the need of the vehicle of the future.

However, the European automotive industry faces intensified global competition due to non-EU manufacturers' early adoption of software-driven strategies. Large tech companies and hyper-scalers, leveraging substantial software budgets and indirect business models, are already dominating specific domains. Additionally, significant state aid in East Asia facilitates rapid market entry for new companies.

The SDVoF initiative specifically emphasizes collaboration across European Original Equipment Manufacturers (OEMs) and suppliers. It takes a **system-level approach** and focuses on **non-differentiating elements** (also known as building blocks) within the vehicle software stack. By fostering coordination among existing alliances and establishing **close ties with EU initiatives related to an open automotive hardware platform**, as well as initiatives **on connected and automated vehicles** or **zero emission mobility**, the SDVoF initiative aims to create a robust ecosystem. Additionally, where appropriate, **Open-Source software** initiatives will be seamlessly integrated.

Two critical approaches drive the SDVoF initiative:

- The first approach is driven by the concepts of **code-first and bottom-Up Integration**: This approach involves assembling the building blocks into OEM-specific SDV software stacks. Starting from the foundational components, such as communication protocols, security modules, and basic functionalities, the integration process gradually constructs a comprehensive software stack tailored to individual OEM's requirements.
- The second approach focus on the **top-down development of an automotive-grade SDV middleware software stack**: In this approach, the focus shifts to the middle layer of the software architecture. Here, the SDVoF initiative aims to develop a standardized, high-quality middleware software stack that abstracts and hides the technological details between the between the hardware and application layers. This middleware stack ensures seamless communication, safety, and reliability across various vehicle functions.

By combining these two approaches, the SDVoF initiative strives to strengthen EU strategic autonomy and leadership in the automotive value chain, positioning European actors at the forefront of future vehicle technology.

The SDVoF initiative envisions a comprehensive development process, organized into three distinct phases:

1. **HW/SW Abstraction**: In this initial phase, the focus lies on creating a clear separation between hardware (HW) and software (SW) components. By abstracting hardware functionalities, the initiative aims to facilitate interoperability and flexibility. This abstraction layer allows for efficient integration of various hardware platforms while ensuring compatibility with the evolving software stack.

2. **Middleware and API Framework**: The second phase centers around building a robust middleware layer that acts as the bridge between the hardware/OS and application layers. This standardized middleware stack provides essential services such as communication protocols, security mechanisms, and data management. Additionally, an API framework ensures seamless interaction between different software modules, enabling efficient development and integration.
3. **Automated DevOps Tool Chain**: The final phase emphasizes automation throughout the software development lifecycle. An integrated DevOps toolchain simplifies the adoption/use of the new software layers and streamlines processes, including continuous integration, testing, deployment, and monitoring. By automating these steps, the SDVoF initiative accelerates development cycles, enhances quality, and ensures timely updates.

To achieve these goals, the initiative will engage in collaborative Research, Development, and Innovation (RDI) projects. These projects will focus on creating essential building blocks, defining the overall structure, and establishing standardized interfaces. Furthermore, a coordination and governance concept will guide decision-making, foster collaboration, and ensure alignment with European actors' strategic objectives.

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1 State of play

1.1 The challenge of software-defined vehicles

As the automotive industry moves towards autonomous, electric, connected, and service-oriented vehicles, hardware and software are becoming increasingly important in managing their operations and enabling new features. In the future, "software-defined vehicles" will be more valuable than traditional vehicles based mainly on mechanical parts, with electronics and software playing a key role in this new paradigm. Customers value new software applications such as infotainment, connectivity, ADAS/AD functionality, and regular over-the-air updates for new or improved functionality during the operational phase of the vehicles, automatically or on-demand. New apps are also combining cloud with vehicle functionalities to increase the comfort and safety of the driver for day-to-day operations such as charging, parking, and driving. Customers are willing to switch brands for these better applications and features.

The software platform, which includes virtualization, operating systems, middleware, and integration with the cloud, plays a key role in this new paradigm. By raising attention to software and hardware, manufacturers can create more value for their customers and stay ahead of the competition.

Embedded computing hardware and software are therefore becoming increasingly important for the original equipment manufacturers (OEMs) in complete lifecycles of the vehicles and enabling new features of vehicles at customers. But enabling new functions through over-the-air software updates raises new challenges.

The electronic architectures of vehicles are becoming more centralized, fueling the demand for next-generation system-on-chip designs and high-performance processors, and redefining how software is designed, integrated, and maintained. The software layers between hardware and applications, including interfacing with the cloud, play a key role in this paradigm shift.

Automotive players are transforming themselves into software-defined companies, but they are facing difficulties with software development. Software complexity is rising sharply, with lines of code in a vehicle expected to grow from 100 million today to a billion by the end of this decade. Increased complexity of functionalities and sharing of computing resources across electronic control units, vehicle domains, and the mobility and cloud infrastructures reduces the software development productivity. Many non-compatible SW platforms used at different OEMs (and often even within one OEM) create big redundant and non-value adding effort in development and even more in maintenance. This leads to delays and cost overruns for software projects. Additionally, the industry is facing a major software talent shortage.

1.2 Rapidly changing competition

The European automotive industry is facing increased global competition in this rapid transition towards SDV as new non-EU manufacturers have an advantage on software productivity, having adopted a software-driven approach from the outset. Large tech companies and hyper-scalers with enormous software budgets and resources, exploiting indirect business models, are entering the market and already dominate certain domains. Moreover, significant state aid, especially for new companies in East Asia, allows them to enter the market rapidly.

With these software-capable players such as Tesla or BYD blazing a new trail in this regard and anchoring customer expectations, traditional well-established OEMs are forced to catch up and rapidly build sought-after features. Large non-EU semiconductor companies are offering integrated hardware-software platforms and have announced numerous automotive partnerships leading to vendor lock-in and dependencies. The above-mentioned hyper-scalers are expanding their power on consumer platforms into the vehicle. These transformations are putting the strategic autonomy and competitiveness of the European automotive industry at risk.

To address these challenges, automotive companies need to focus more on modular software with improved maintainability, portability, and faster time-to-market without sacrificing automotive quality and ensuring the evolution of modern vehicles. By focusing on software and hardware, manufacturers can increase value for the end-users and stay ahead of the competition.

1.3 Industry and EC takes up the SDV challenges

So far, EU car companies have focused on developing proprietary technology platforms, impeding efficiencies when such investments replicate efforts on elements that are not differentiating and visible to the customer. A rising number of partnerships and alliances across varying types of actors of the automotive and digital ecosystems shows a growing openness to join forces. They however do not cover systematically all the non-differentiating elements of the software stack and lack in many cases sufficient implementation. They would benefit from stronger cross-initiative coordination and governance.

In this context, the European automotive, embedded SW and semiconductor industry together with the European Commission have started complementary but distinct industry driven initiatives to reinforce EU strategic autonomy and leadership in the automotive value chain on the vehicle of the future. They address the need for an open automotive hardware platform and an open "Software-Defined Vehicle of the Future" (SDVoF) ecosystem driven by European actors. The SDVoF initiative focuses on an open and pre-competitive collaboration across European OEMs and suppliers on non-differentiating elements of the vehicle software stack. This initiative aims to reinforce the coordination between existing alliances by orchestrating distributed developments and ensuring close links with EU initiatives on an open automotive hardware platform. Stronger cross-initiative coordination and governance would benefit these partnerships and alliances.

2 European initiative on the "Software defined Vehicle of the Future (SDVoF)"

2.1 Towards in an SDVoF ecosystem – Objectives and goals of the initiative

To overcome the challenges described in section 1, the SDVoF initiative has jointly identified on the following objectives:

Objective 1: Improving agility and automotive grade quality in (hardware and) software development

Automotive software (onboard, and increasingly also offboard) has always had particularly high quality, reliability and dependability requirements. Being safety-critical systems, vehicles need to fulfill stringent safety and security standards and legislation, with emphasis on development methods, processes, verification, and validation. The first objective of this initiative is to improve development agility while sustaining automotive grade quality.

Open-source plays a significant role in the global software industry. The success of the Linux operating system, the software components in most of the cloud software systems, and many more applications gained agility and development speed through open-source approaches. Therefore, the SDVoF initiative also adopts an open-source approach wherever possible and useful. Moreover, open-source software (OSS) projects provide global open access (if not restricted by law), which has shown to attract top talent, thereby building an ecosystem with pools of experts needed in industry. Additionally, the "code-first" approach shall ensure that time-consuming standardization and industrialization work is only spent on successfully implemented, integrated, and tested software building blocks.

It is intended to avoid time-consuming and costly unnecessary developments in using available components and concepts as much as possible. Cooperation with all relevant initiatives such as COVESA, SOAFEE, AUTOSAR, ECLIPSE-SDV, etc., is essential.

Objective 2: Reduce time-to-market and developing costs by collaboration

Collaboration in non-differentiating areas together with automation - wherever possible and useful - in the whole lifecycle of software from inception, development, maintenance to field monitoring across OEM and Tier boundaries shall deliver the necessary agility in the development process, significant reduction of development costs as well as a faster time-to-market.

Objective 3: Support new business models in the automotive industry enabled by the Open SDVoF platform

As Software defined vehicles will be updated and functionally extended throughout their operational lifetime (via over-the-air updates), new (largely service oriented) business models are introduced on the automotive industry. The SDVoF SW structure and building blocks shall support this new automotive business models.

Objective 4: Fostering open communities for collaborative creation of Open SDV source SW components

Collaboration with existing open-source initiatives and fostering the creation of new open-source communities shall create a vibrant open-source ecosystem for SDVoF SW stack components. Close alignment with the sister initiative "High-Performance Automotive RISC-V Reference Platform" shall allow fast take-up of new European SDV-HW platform implementations.

Objective 5: European strategic autonomy in SDV-HW and SDV-SW

The creation of an European SDV software ecosystem working on a commonly agreed SDV software structure and (open-source) building blocks will help to ensure the European strategic autonomy in SDV software. Similarly, the sister initiative on "High-Performance Automotive RISC-V Reference Platform" will do the same on SDV hardware.

Objective 6: Joined effort of industry and public authorities for the design and implementation of an Open SDV platform

The establishment of a level playing field for the European SDV industry in the fierce global competition shall be achieved by public-private cooperation in funded projects constituting the SDVoF initiative. Common non-differentiating building-blocks, an agreed SDV software structure and consensual interfaces will enhance technical interoperability and help create an open ecosystem. This will reduce vendor lock-in allowing companies to compete in a fair way. By relying largely on open-source and by ensuring transparency and broad dissemination, the initiative will allow actors outside the funded projects to participate in the ecosystem.

2.2 Guiding principles towards the objectives of the SDVoF initiative

The initiative addresses the following areas:

- The development of non-differentiating building blocks which help to develop SDV SW stacks faster and more efficient.
- The creation of a reference structure for SDV SW stacks (based on open APIs).

The development of methods and tools for automotive software engineering, which cover the complete life cycle of software defined vehicles.

The guiding principles for the initiative agreed by the industry are explained in the following sections.

Collaborative development of open non-differentiating building blocks

All OEMs are currently working on OEM specific SDV software architectures in various partnerships. The initial focus of the "Software-Defined Vehicle of the Future" initiative is the creation of software building blocks, which will be integrated and used in company-specific SDV software stacks. A consensual definition of interfaces for these non-differentiating building blocks is highly important. The integration into the company (OEM or Tier) specific software stacks may require adding thin layers of company-specific software ("glue logic") to cope with the differences in the existing as well as future company-specific architectures.

As the focus of the building blocks is in the non-differentiating area, they will reside in mainly layer 2 depicted in in Figure 1 on page 11, which consists of essential functionalities as virtualization, car (meta) operating system, HW/SW abstraction, the on-board middleware, API framework and cloud middleware. Virtualization concepts are a key concept for safety relevant (and mixed-criticality) implementations of the vehicle SW stack. They are considered as differentiating. Therefore, implementation might not be open source, but agreement on common interfaces is crucial.

Open-source and Code-first

The initiative adopts "code-first" principles to create fast tangible outcomes for the industry. Together with demonstrators and ecosystem building, open-source code development will become the foundation and a crucial success factor of the European SDV ecosystem and drive industry standards in an agile and widespread adoption, thus helping to reduce time-to-market. Only building blocks used successfully in industry SW stacks will be used as base for standardization of interfaces.

The "Code-first" approach has several goals:

- Iterative development to sequentially improve building blocks and integrate them as soon as possible into industrial SW stacks. Standardization effort is only started, when building blocks have proven their functionality, robustness, and quality in real-world usage.
- Test driven development is a very good development methodology of an agile "code-first" approach. It basically means, that the test procedures are designed and already implemented as part of the requirement specification. This also helps to significantly improve the quality of requirements and subsequently of the code. Additionally, it supports the automation of testing.

"Open-source" is used because:

- The use of open-source in the non-differentiating layer of the SDV SW stack creates an open ecosystem to achieve pre-competitive goal. It helps to avoid the risks of violating competition laws, and thus helps to ensure the compliance with antitrust regulations.
- The creation and use of open-source allows universities and research institutes to use and contribute SW components in their Research and educational programs. This is an essential contribution to solve the shortage of SW talents in the automotive industry.
- The automotive industry is already using many open-source components in industrial SW stacks of vehicles. They are mainly used in non-safety critical areas as infotainment, communication etc. These open-source components are in most cases not initiated, specified, and developed by automotive companies. As the SDVoF SW stack also includes many safety-critical SW components, the extensive experience of automotive OEMs, suppliers and academia is necessary to create open-source building blocks useable in automotive SW-stacks. This requires a transition from "consuming only" open-source to "contributing and consuming" open-source in the automotive SW industry.

Agility and speed through rapid demonstration in representative use-cases

To pave the ground for rapid adoption of new components, emerging building blocks will be demonstrated gradually in representative use-cases. This should help participating companies to integrate them as soon as possible in the SW stack of their future solutions, products, and vehicles in general.

HW/SW abstraction and virtualization

The SDVoF initiative aims to provide a modular and scalable software architecture for OEMs and Tier1s to build their SDV systems. The initiative focuses on decoupling software-implemented functions from the underlying hardware, reducing dependencies and vendor lock-in. However, it is important to note that becoming hardware agnostic does not mean becoming hardware ignorant. Hardware requirements must be defined from the SDV application perspective, and emerging hardware features must be exploited in software for performance optimization, additional functionality, or safety/security. It is important to note, that HW requirements need to be defined early and stay fixed, the requirements for the SDV SW applications are changing over the lifetime of the car.

The SDVoF initiative is therefore closely collaborating with the sister initiative "High-Performance Automotive RISC-V Reference Platform". For OEMs, the HW and SW abstraction layer simplifies the migration from existing OEM specific (often non-European) automotive high-performance computing platforms to new HW platforms based on the results of the sister Initiative "High-Performance Automotive RISC-V Reference Platform".

Working in a common structure of the SDV SW stack

The initiative has agreed on a three-layer structure for SDVoF HW/SW stacks as depicted in Figure 1. The initiative aims to develop collaboratively non-differentiating building blocks in the "Middleware and API framework" and "Car meta operating system & HW abstraction" layers with implementations in-vehicle as well as off-board in the cloud. Wherever useful and possible, open-source shall help to gain agility as well as a selection of the best SW technologies and/or solutions. The building blocks will be used in existing or new SW stacks of OEMs or tiers, which will bring the new functionalities into vehicles on the road.

Facilitated by DG CNECT (Directorate General for Communications Networks, Content and Technology) of the European Commission, experts from the European automotive industry have organized several workshops to create a layered model (see Figure 1) of SDV SW stacks.

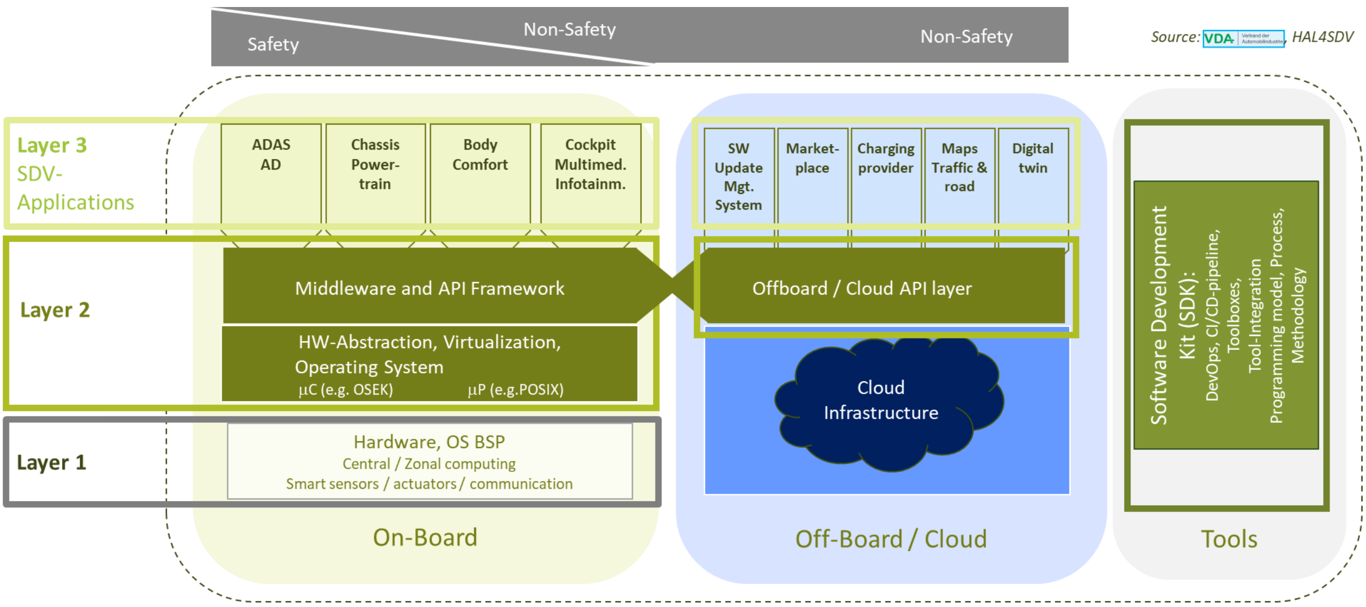

Figure 1 Basic structure of SDVoF HW/SW stack

The SDV structure in Figure 1 abstracts the HW resources as processor resources, sensors, actuators, data coming from various communication media as well as data in the cloud (e.g. about traffic status) and the services build upon them for the application software used by vehicle drivers and passengers. This shall increase development efficiency and agility for user-relevant software applications. The SDVoF HW/SW-stack consists of the following layers:

- **Layer 1 (SDV-Hardware):** This layer includes all hardware components as automotive high-performance compute-platforms (HPC) and domain controllers and the SW abstraction of resources of the HPCs and domain controllers required for the largely AI-based software, serving several automotive domains with applications satisfying requirements like non-safety critical, safety critical, security, energy efficiency, etc.

- **Layer 2 (SDV-middleware & hardware abstraction & OS):** This software Layer 2 is the major focus of the SDVoF initiative. It consists of (mainly open-source and mostly non-differentiating) software building blocks, which connect the hardware layer with the applications layer to allow separated hardware and software development cycles necessary for software-defined vehicles of the future. This layer also ensures the safe execution of the applications of layer 3. It shall consist of software building blocks, which can also be used in existing OEM specific SW stacks. As many applications have on-board and off-board (cloud) parts, a service-oriented interface layer shall also exist in the cloud.

  Layer two consists of two sub-layers: 2a) HW abstraction, virtualization, and operating system (OS) and 2b) SDV middleware and API-framework.

  Layer two may be use different operating systems in different software-defined vehicle domains such as infotainment, ADAS, automated driving, chassis/powertrain control, body-comfort, etc., but the interfaces shall be the same.

- **Layer 3 (SDV-Applications)**: This layer contains the differentiating parts with applications in automotive domains such as infotainment, automated driving, advanced driver assistance functions, chassis and powertrain control, cockpit user interfaces, e-charging, routing, (body-)comfort functions, etc. Many of the applications have parts onboard of the vehicle and other parts in the cloud.

Tools and tool chains designed for the SDV of the future

The complexity of vehicle software stacks in SDVs is increasing rapidly, especially for safety-relevant features (e.g., automated driving, vehicle-to-grid) for SAE level 2 to 5. This makes it very likely that new unknown safety critical situations and scenarios will arise in the operational phase of the vehicle despite rigorous hazard and risk analysis (HARA) and V&V in already in early phases of the development. This can lead to safety hazards or security issues for passengers and other traffic participants, which will therefore require software corrections and updates in very short time periods.

The SDV SW stack must support continuous updates during the life-cycle of the cars using update functionalities offered by the stack itself. These updates can be perfective as well as corrective updates. As corrective updates may have to solve safety critical issues, the integration and testing of the complete SW stacks must be completed in single digit weeks compared to double digit month nowadays. This motivated the second important part of the initiative: the development of new SW-DevOps Standard Development Kits (SW-SDKs). SW-SDKs include new methods, CI/CD toolchains, tool-building-blocks, and building blocks covering the complete life-cycle of SDV SW stacks, providing automated functionalities for the creation and delivery of SW stacks This layer includes new methods and corresponding building blocks for tools and toolchains covering the complete life-cycle of SDV SW stacks, which allow the creation of SW stacks deliveries. The building blocks of the DevOps tool-chains shall use existing proven components (tools) wherever possible; open-source plays also here a major role. More details are described in the subsequent paragraph.

Furthermore, the trends towards more complex software functions and the concentration of software on central computing platforms lead to a significant larger complexity and increased time periods required to test new software updates. Current workflows and modes of collaboration between OEM and multiple tiers complicate integration, testing, and bug fixing in the software distribution process significantly. Today's time span between implementation of a software bugfix and delivery of the modified software over-the-air to vehicles might reach a couple of months, which is not acceptable anymore. New processes and related development tools are required to largely automate this process and are therefore also in the scope of this initiative. AI-based and model-based technologies are promising to improve and speed up the specification, implementation, and test steps. As a result, software updates will be created and deployed much faster and more frequent, which not only keeps vehicles safe and secure, but can also raise brand attractiveness through "software freshness", enabling new functionalities and experiences to users.

Support of the collaborative development of high-performance (open) SOCs designed for SDVoF

This SDVoF initiative will closely work together with the sister initiative "High-Performance Automotive RISC-V Reference Platform". This will ensure a fast integration of the new high performance automotive SOC developed in the sister initiative with the SDVoF SW buildings blocks and reference SDVoF stack of this initiative.

Close collaboration with existing initiatives to avoid "reinventing the wheel"

Agility and development speed are crucial challenges. It is mandatory to reuse existing proven building blocks and design patterns wherever possible. Cooperation with accepted initiatives in the automotive industry working on various aspects of the SDV are essential to avoid duplication of effort and to reduce the time-to-market. Essential partners to the SDVoF initiative cover different important stakeholder groups.

Automotive middleware software initiatives

AUTOSAR[1] (AUTomotive Open System ARchitecture): AUTOSAR is a global partnership of leading companies in the automotive and software industry to develop and establish the standardized software framework and open E/E system architecture for intelligent mobility.

COVESA[2]: COVESA is an open, collaborative and impactful technology alliance; accelerating the full potential of connected vehicles. The workgroups in COVESA focus on Data models as the Vehicle signal specification (VSS), common vehicle interfaces, electric charging as well as other topics.

SOAFEE[3]: SOAFEE is an industry-led collaboration between companies across the automotive and technology sectors working together to build open-source architecture for software-defined vehicles. Together to work on creating a shared platform for vehicles using cloud-native architectures that accommodate multiple hardware configurations.

Catena-X [4]: CATENA-X is an open and interoperable data ecosystem and an open-source community. Its goals are: Give transparency and provide an environment for the creation, operation, and collaborative use of data chains along the automotive value chain.

Automotive Open-source software stakeholders

Eclipse SDV[5]**:** Eclipse Foundation is providing an open technology platform for the software defined vehicle of the future; accelerating innovation of automotive software stacks through a vibrant open-source community.

[1] Home AUTOSAR: https://www.autosar.org
[2] COVESA: https://covesa.global/
[3] Soafee: https://www.soafee.io/
[4] Catena-X: https://catena-x.net/en/
[5] Software Defined Vehicle | The Eclipse Foundation: https://sdv.eclipse.org/

Automotive industry associations

ANFIA[6]: It represent the interests of its associate members (automotive component manufacturers, car designers and engineering companies, motor vehicle companies) and ensure effective communication between the Italian motor vehicle industries on the one hand, and the Public Administration and Italian political bodies on others, regarding all technical, economic, fiscal, legal, statistical and quality-related issues referred to the automotive sector.

PFA [7]: The Automotive Platform (PFA) brings together the automotive industry in France. It defines and implements, on behalf of all partners (manufacturers, equipment manufacturers, subcontractors, and mobility players), the sector's strategy in terms of innovation, competitiveness, employment and skills. It carries the voice and expression of the common positions of the sector.

VDA[8]: VDA is the association of the automotive industry (VDA) in Germany. It works on the right framework conditions so that its member companies, from start-ups to global corporations, can realize their visions as climate neutrality until 2050 and successfully bring their offerings to market.

EUCAR [9] : EUCAR, the European Council for Automotive R&D of the major European passenger car and commercial vehicle manufacturers, is the R&I arm of the European Automobile Manufacturers' Association (ACEA[10]). EUCAR facilitates and coordinates pre-competitive research and development projects; its members participate in a wide range of collaborative European R&D programs.

CLEPA[11]: CLEPA represents over 3,000 European companies supplying state-of-the-art components and innovative technology for safe, smart and sustainable mobility.

Defined governance of the SDVoF initiative

The SDVoF initiative is a collaboration between the European commission, public authorities of participating states in funding programs as the Chips-JU, and the industry to tackle the challenges in the global SDV market together. The initiative is under the governance of the SDV Sherpa Governance Group (SDV-SGG) acting as a steering "board", providing direction, vision and validating roadmaps. The members of the Sherpa governance group get their direction from C-Level representatives of the industrial stakeholders participating in the SDVoF initiative. Collectively, the members of the group represent the common interests of the European automotive industry.

6 ANFIA: https://www.anfia.it/en/
7 PFA - Automotive Platform: https://pfa-auto.fr/
8 Verband der Automobilindustrie e. V. | VDA: https://www.vda.de/de
9 EUCAR - European Council for Automotive R&D: https://www.eucar.be/
10 ACEA - European Automobile Manufacturers' Association: https://www.acea.auto/
11 CLEPA – European Association of Automotive Suppliers: https://clepa.eu/

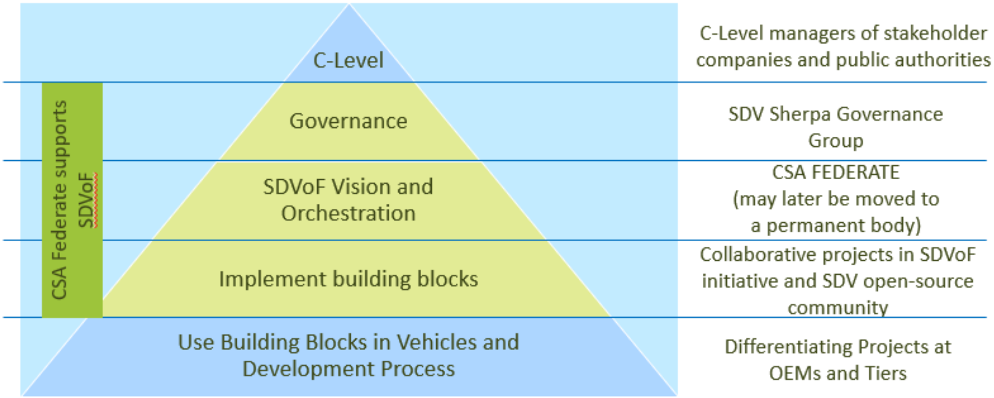

Figure 2: SDVoF governance structure

The SDV-SGG develops the guiding principles for the vision and roadmaps of the SDVoF initiative. The SDV-SGG oversees and governs the work of the coordination and support action FEDERATE and the funded projects initiated by the SDVoF initiative. Participants of the SDV-SGG aim to establish a strategic collaboration to create a strong open SDV ecosystem driven by European actors with the shared vision to keep the European automotive industry competitive. The cooperation with the ECLIPSE-SDV initiative can support the strategic use of open-source principles wherever possible and useful. The SDV-SGG also ensures an acceptance and support of the SDVoF initiative in their companies on the executive management level.

An existing or new organization may take over this coordination and support activities at a later stage. Additional discussions with Eclipse SDV, COVESA, AUTOSAR, SOAFEE will be necessary. Several new activities are already emerging such as the *SDV Alliance* (founded by AUTOSAR, COVESA, Eclipse SDV and SOAFEE).

Participation in the SDVoF ecosystem

The SDVoF initiative is driven by the European automotive industry and by the goal to reinforce the industry's strategic autonomy. Considering the global nature of the industry, participants consider it essential to be able to use the outcomes of the initiative in all regions and to drive standards on the global market. European leadership on the one hand, and openness and collaboration with the broad ecosystem, including companies from other regions, on the other hand, is a key success factor.

The different levels of the initiative allow for three degrees of participation:

Strategic governance level: the participation in the SDV Sherpa Governance Group of representatives of EU headquartered OEMs, Tiers, and Associations, which is facilitated by DG CONNECT and supported by the Co-ordination and Support Action under the Chips JU FEDERATE, ensures that the direction and vision of the initiative and its projects are aligned with the objective of reinforcing the competitiveness of the European automotive industry.

Participants in EU-funded projects: Contractors (partners and associated partners) supporting the orchestration of the initiative and its implementation are subject to the participation rules for the instruments funding these projects. As of 1 April 2024, projects FEDERATE and HAL4SDV (both Chips JU) are considered projects under the SDVoF initiative. The portfolio is planned to be extended in 2024/25 through new contracts funded under the Chips Joint Undertaking and the Horizon Europe Partnerships CCAM and 2ZERO. The participation of new partners and associated partners in running projects under the SDVoF initiative must be approved by the participants of the respective projects making sure it supports the initiative's goals. Details on rights and obligations are fixed through consortia agreements between partners and associated partners on project level. In future, notions like "linked projects" or Framework Partnership Agreements may be considered for supporting tighter collaboration across EU-funded projects.

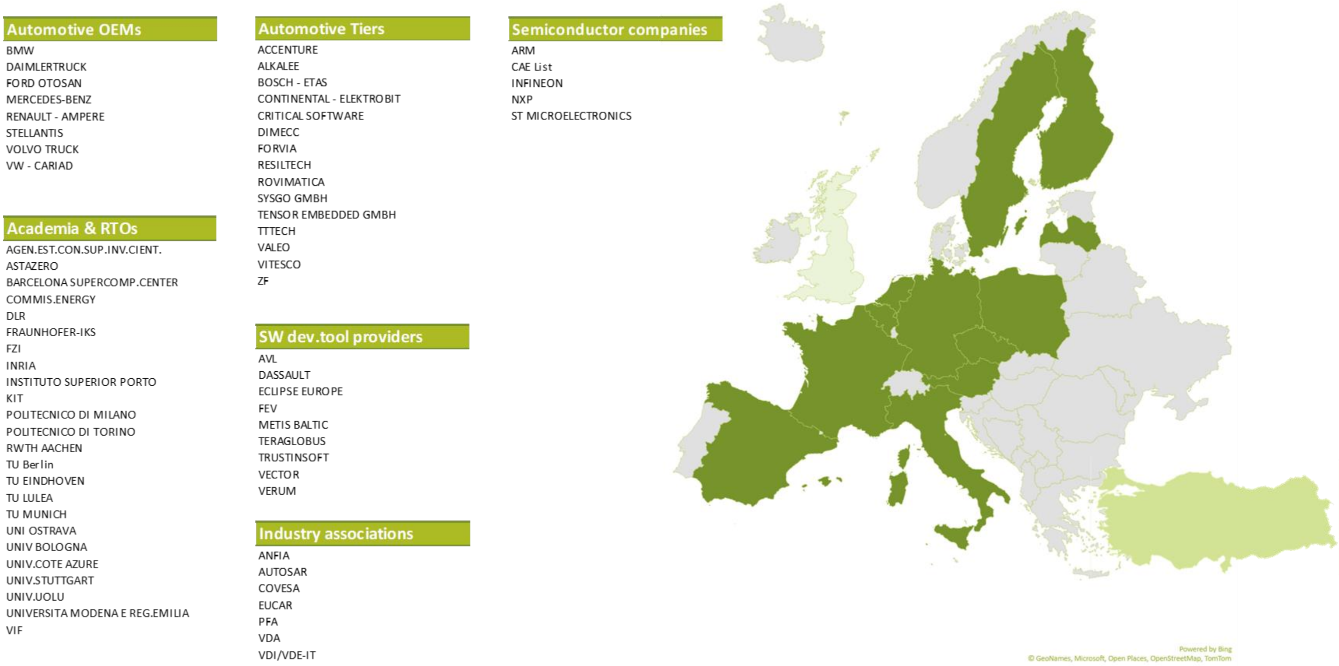

Figure 3: Participating organizations/companies in SDVoF EU-funded projects (as of Apr 10th, 2024)

Open European SDVoF Ecosystem: It allows all interested stakeholders from any region in the world to participate in the SDVoF ecosystem through open conferences, workshops, or open-source communities:

- **Staying informed by joining the Open European SDVoF Forum:** All interested SDV stakeholders are invited to join free of charge the Open European SDVoF Forum via registration on the Federate Website. All Open SDVoF Forum members get regular updates about the European SDVoF initiative, invitations to networking events and information about relevant conferences.
- **Contributing to and using Open-Source Ecosystem results**: Since a large part of the outcomes of the initiative will be open-source, they will be open by nature to any actors in the open-source ecosystem, under the limitations of the OSS license and the rules of the relevant open-source foundations or entities. Actors outside the EU-funded projects will be able to contribute to OSS projects and use their results. This only applies to results of projects under the SDVoF initiative which are in the public domain (e.g. as an open-source activity). Participants in the SDVoF initiative, by their active contributions and strategic steering, will be the ones driving. This put them in a privileged position for exploiting the results.

3 Expected results of the SDVoF initiative

Rapid progress is essential, as the transformation described in section 1 is already in full swing. The key elements of the European SDV of the future initiative laid out in section 2 are expected to unfold their benefits to the European automotive industry as well as to vehicle customers and operators very fast.

3.1 Large positive impact on the open SDV communities and SDV tool ecosystem

The SDVoF requires a large cohort of excellent engineers, designers, and scientists available at OEM's tiers, SW vendors, industrial research, and academia. The coordination and support action (CSA) FEDERATE started 2023 and will foster the vibrant European SDV community needed, by organizing the annual SDV Ecosystem forum, developer conferences, training activities etc. The projects jointly funded by public authorities and industry in the SDVoF initiative will speed up the creation of the open SDV communities and SDV tool ecosystem.

3.2 Pool of open automotive grade building blocks for SDV SW stacks (bottom-up approach)

As explained in chapter 1, the SDVoF initiative focuses on the development of non-differentiating reusable software building blocks for SDV software stacks in the vehicle and in complementary parts on the cloud and agree on their interfaces. This will help speeding up the development of SDV software stacks, their integration, and deployment in commercial products.

These building blocks shall be developed in several collaborative projects by a vibrant SDVoF ecosystem. The building blocks often developed as open-source in this community can then be industrialized, integrated, and tested in existing OEM/Tier-specific SDV software stacks, to be subsequently used in vehicle software updates. This bottom-up open-source-based approach generates short-term benefits and ensures that the most attractive building blocks will obtain a sustainable position in the ecosystem. The collaborative development of non-differentiating yet essential building blocks for the SDVoF in public-funded research, development, and innovation (RDI) or other open-source projects will result in a significant reduction of the development costs by sharing them across the industry and public authorities if we avoid added complexity due to collaborative development. Yet, this approach is also expected to result in highly dependable, robust, secure, and well-tested components, based on commonly agreed concepts and interfaces.

Candidate building blocks are expected in the “Middleware and API framework”, the “HW abstraction, virtualization, operating system”, as well as the “off-board / cloud API interface” layer, and in the supporting SDV engineering methods and tools. The open-source approach supports the “Survival of the fittest” principle in case of competing building block implementations.

In the first phase starting in 2024, the focus is on building blocks in the layer 2a and 2b (see Figure 1), addressed by two collaborative RDI projects in the Chips-JU program (call 2023 for layer 2a HW/SW abstraction, and 2024 for layer 2b middleware & API framework). In parallel, the next generation HW SDV computing layer will be developed in sister automotive RISC-V initiative in the Chips-JU program (more details, see chapter 1).

Building blocks shall be continuously maintained and extended to fully support new HW components and deliver new functionalities. The necessary infrastructure must be setup in the coming years.

This shall allow OEMs and tiers to quickly migrate from the existing HW to the new HW developed under the open “High-Performance Automotive RISC-V Reference Platform" in the sister-initiative, facilitating the integration of emerging European high-performance HW.

3.3 Reference SW stack composed of SDVoF building blocks (top-down approach)

SDVoF reference structure

A commonly defined reference structure supplies the groundwork for all following activities. The reference structure is derived from the result of workshops in the Sherpa Governance Group depicted in Figure 2 and on-going work in the FEDERATE project team. A common glossary for the precise definition and mapping of terms goes with the reference concept. The FEDERATE project will continuously improve and update both the reference structure and a glossary to ensure design consistency considering also safety, security, and privacy.

Common layer definition and high-level interface description

Based on the multi software-layer approach, the (micro-)services and their high-level interfaces will be defined. This will ensure consistency and interoperability of the results.

Design a reference structure and SW stack from the building blocks of the SDVoF initiative

In parallel to the usage of bottom-up building blocks in OEM specific SDV SW stacks, a reference SDVoF software stack shall be implemented as open-source in projects (see Figure 4) to ensure the consistency and fitness of the building blocks. Scientific knowledge and best practices from the industry will be integrated in a joint effort to develop the building blocks and the reference SDV SW stack. Over time, common interfaces and building blocks will lead to further convergence between currently available unaligned OEM specific SDV architectures in the market.

The reference SDVoF SW stack can in a later step be industrialized and subsequently integrated into products of OEMs or tiers (top-down approach). In that case, an association or similar entity should take over the further coordination to establish a working business model and ensure the development, maintenance, and quality assurance of software building blocks for the SDV SW stack and the SDV engineering environment.

Both approaches “bottom-up” and “top-down” are explained in more detail in the following chapter.

Bottom-up and supplementing Top-down approach

The initiative follows two approaches: in the first phase of the initiative the *bottom-up* is used (implementing building blocks, which are then integrated into existing software stacks), and later a *top-down* approach is added (starting from a harmonized SW stack and implementing missing building blocks). The bottom-up phase ensures the inclusion of the existing (legacy) technologies in the SDVoF, introducing an inclusive ecosystem for the EU stakeholders. The top-down phase will support and guide this ecosystem to the full adoption and exploitation of industrialized HW/SW stacks for SDVoF. Functional clusters will combine building blocks required for different functionalities as for example secure cloud communication, plug & charge etc. in different views.

These two approaches are depicted in Figure 4:

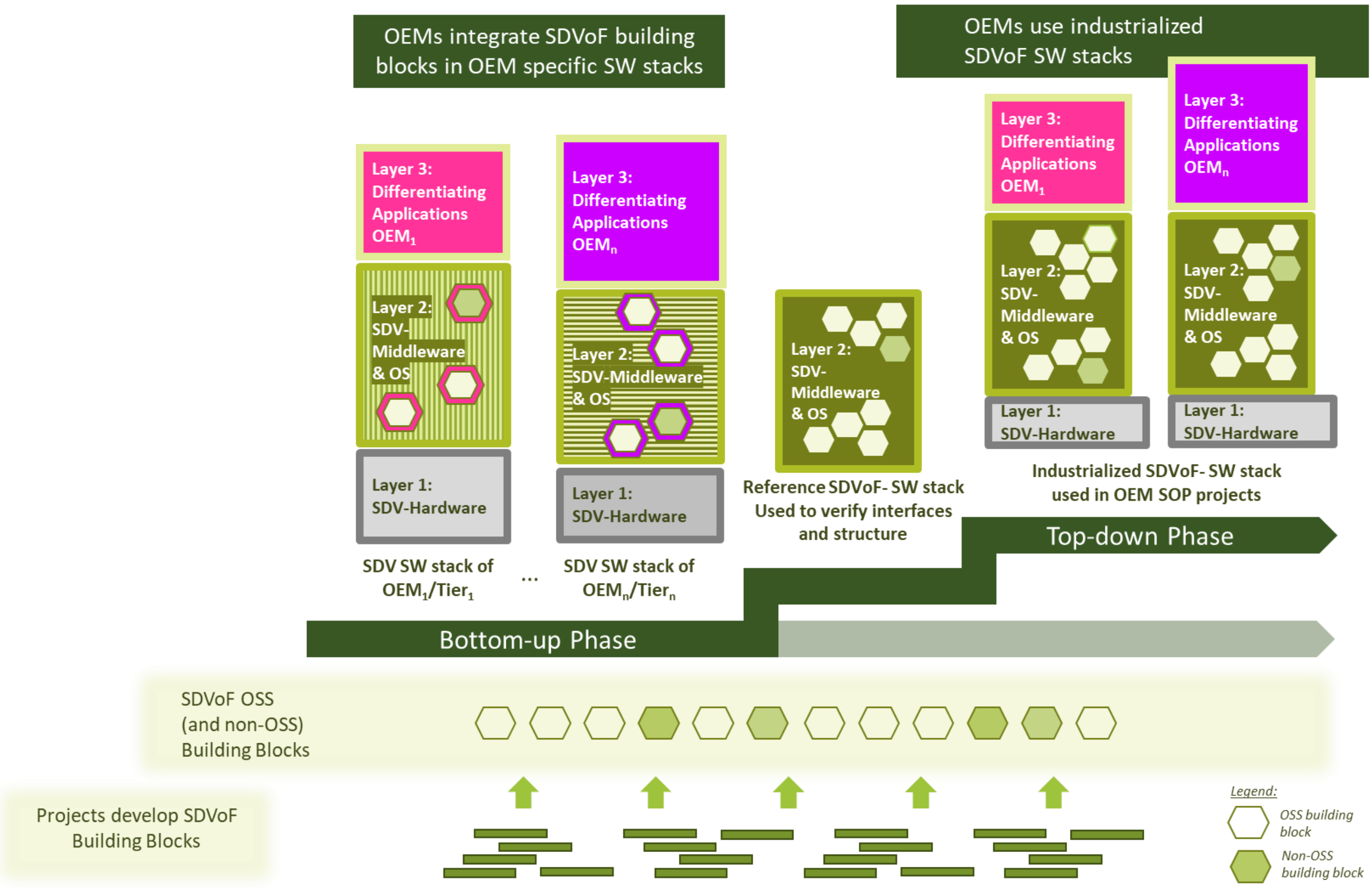

Figure 4 Integration of SW building blocks into industry specific as well as reference SW stacks

The focus on the creation and usage of collaboratively developed non-differentiating building blocks in the first phase of the initiative provides speed and efficiency in the use of the results by the OEMs in their SDV products. This bottom-up approach considers that OEMs and tiers are already using different architectures and are working in different existing collaborative initiatives (e.g. AUTOSAR, COVESA, ECLIPSE-SDV, ...).

The top-down approach will follow in a second phase. It shall create a reference structure and a corresponding SW stack from the building blocks of the SDVoF initiative, heavily supported by the work of the scientific board of the CSA FEDERATE. It shall ensure a future proven architecture and a consistent structure on which the non-differentiating building blocks are based. This also supports the interface standardization of building blocks, whenever they are successfully used in software defined vehicles on the market. As last step, an industry association, an automotive company, or a similar entity can then industrialize the reference structure and create a well-tested and maintained automotive quality grade open-source based middleware for SDV, which can be used in parts or as a complete stack by OEMs. This can again significantly reduce the development effort for SDVs and allows OEMs to faster deliver new SDV functionalities to the market.

3.4 Automotive grade SW engineering environments for the whole SW lifecycle for SDVoF

To supplement the fast, agile, and efficient development of SDV SW stacks, the SDVoF future has also a focus on a significantly improved automotive SW development and validation methodology combined with corresponding toolsets. This shall allow the fast creation of dependable, secure, and efficient SDV software. It shall also support the fast deployment of high quality over-the-air software updates to the market. This is especially important in the ADAS/AD (Advanced driver assistance systems / automated driving) application domain. This advanced support for HW/SW engineering also represents a crucial factor to cope with the lack of skills Europe is experiencing and with the lack of human resources, which can be mitigated through the high automation of HW/SW engineering.

Methods and tools for efficient and fast cross-company collaboration

OEMs will continue, and due to the growing SW complexity even intensify, a tight collaboration with tiers, SW and data vendors, and hyper-scalers. Therefore, a seamless integration of automated CI/CD-toolchains allowing tight connected workflows across partners is required. This will ensure that SW updates can be deployed and become available at vehicle level in single digit days (compared to sometimes double-digit weeks today) in a secure way.

Methods and tools for fast and efficient verification and validation

The development, testing and release (including re-homologation if needed) of SW deployments requires (nearly) fully automated continuous integration / continuous deployment (CI/CD) cloud-based tool-chains to get the envisioned large productivity gains. Automotive-grade quality standards must still be ensured by rigorous quality checks. Therefore, adequate methodologies and tools will also be required for OSS components, covering all aspects of verification (including test-driven development, regression testing, and homologation support, handling corrective vs. perfective maintenance). This will be addressed by collaboratively implementing and integrating building blocks in CI/CD – Test pipelines. Whenever possible, already existing components on the market will be used. Industry-standards, partially open-source test tools and methods are therefore expected to become major contributors as enabler for industrial use.

4 Roadmap for the SDVoF SW stack

The Software Defined Vehicle of the Future initiative together with the sister "High-Performance Automotive RISC-V Reference Platform" initiative are committed to support the implementation of the building blocks (software and hardware) for the Software Defined Vehicle of the Future through a sequence of funded research, development, and innovation (RDI) projects (see Figure 5).

4.1 Roadmap for SW building blocks and middleware

Many of these projects are publicly funded projects in different EU or national RDI programs. The described governance structure (see page 14) gives direction and organizes the exchange of information and results towards realization of the vision of the European SW defined vehicle of the future initiative. This is complemented by the creation and nurturing of a vibrant SDV ecosystem supported by a coordination & support action.

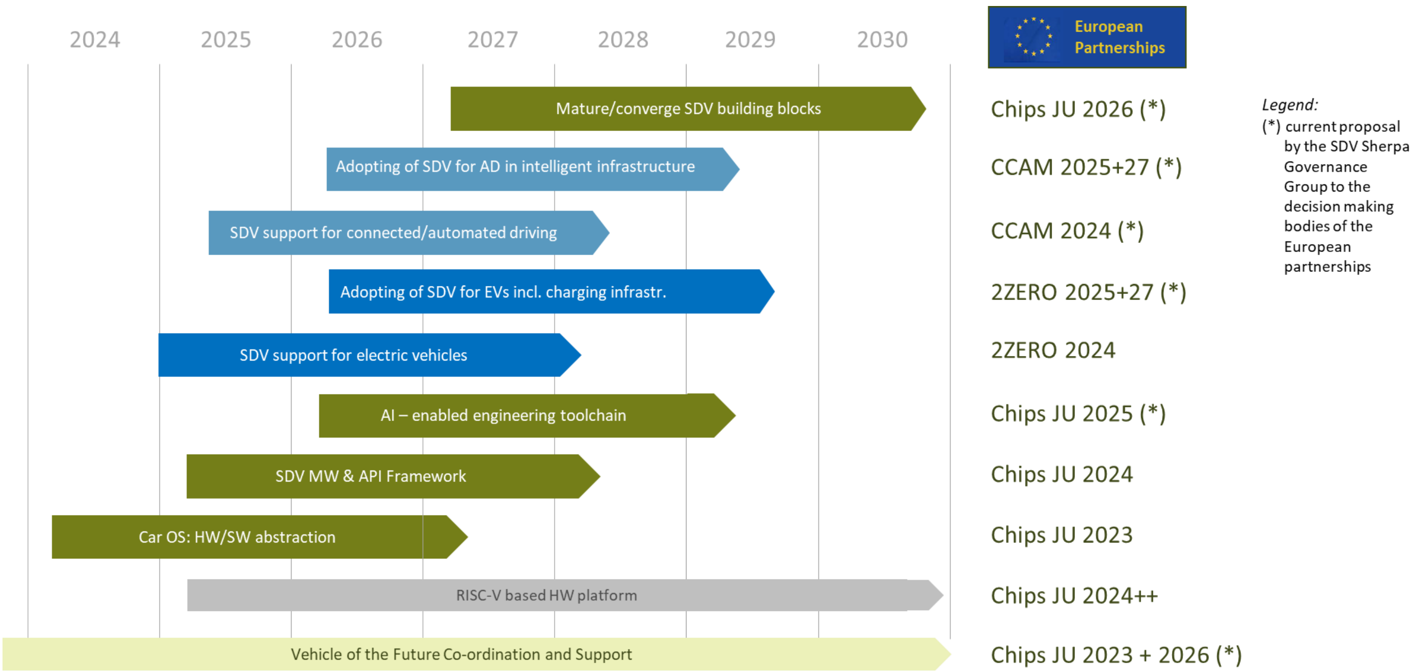

Figure 5: Roadmap of the SDVoF initiative

The roadmap in Figure 5 is organized according to the SDV SW stack structure model used in the initiative. The SDV ecosystem is working in several projects organized in phases mirroring the layers to realize the non-differentiating building blocks and reference implementation defined in the SDVoF initiative as well as building blocks for the SDV DevOps tool chains.

The building blocks developed in the initiative will be combined with company specific SW building blocks and hardware components to implement application use-cases as well as the proofs of concept described in Table 1. The proof of concept (PoC) use-cases (UC) in the projects shall demonstrate achieved objectives of the SDVoF initiative.

The roadmap shows the development of the different layers (explained on page 11) of the SDVoF

SW stack. Many building blocks might even require a sequence of projects. These projects ("linked-projects") are built on top of each other and use the results of previous. The building blocks will be used already in early phases in industrial stacks as described on page 18, while in later phases of the initiative the results of the projects in the different layers will be integrated into industrialized stacks, which can used by OEMs or tiers.

The planned work in the development of the different layers is explained in more detail on the following pages.

Work in layer 2a HW/SW abstraction

Concept, methods, and components for a highly performant, scalable, and cyber-secure hardware abstraction provides the foundation of SDV stacks. The de-coupling of HW and SW enables SW-definable functionalities (both real-time (RT) and non-RT) throughout the stack with full functional flexibility. This will allow reusability, code portability and fast time-to-market. It is complemented by developing appropriate tool chains for fast integration and standardization.

Project HAL4SDV (Hardware Abstraction Layer for Software Defined Vehicles) was selected to cover this layer in the HORIZON-KDT-2023 call and started in Q2-2024. The development work will be done in close alignment with the planned project "High-Performance Automotive RISC-V Reference Platform" in the non-initiative call of HORIZON-Chips 2024-1-IA-T2[12].

Planned in layer 2 b Middleware and API-framework (Chips-JU 2024 focus topic IA)

The upper part of Layer 2 of the SDV stack shown in Figure 1 consists of basic services and building blocks are required for exposing high-level system services and APIs to the layer 3 differentiating SDV-applications. The middleware and API framework builds on top of the interfaces of the hardware abstraction layer developed in the HAL4SDV project. Interoperable, and non-differentiating building blocks will simplify to build modular platforms, which enable fast and efficient development of in-vehicle and cloud-based applications. Integration into existing OEM/Tier specific SW stacks, and support of existing framework initiatives such as ECPLISE SDV, AUTOSAR Adaptive, COVESA, SOAFEE, digital.auto is essential.

The Chips-JU focuses on the development of the necessary building blocks in the middleware. A project proposal working on building blocks in this layer is supposed to be selected in the HORIZON-Chips-2024 non-inititiave cal[13]l to address these topics, starting in Q2 of 2025.

Additionally, calls in the CCAM private public partnership[14] are expected to contribute building blocks to the middleware and API-framework (e.g. cyber-security, communication to cloud services, piloting the emerging SDV framework for automated vehicles in mobility infrastructure, use SDV building blocks for auxiliary functions, …) as well pilot the usage of the building blocks in vehicle applications in cooperative, connected and automated mobility use-cases.

[12] HORIZON-Chips-2024 Work programme 2024 (Non-initiative part) 1-IA T2 Focus topic on "High Performance RISC-V Automotive Processors supporting SDV"

[13] 2024-1-IA-T3 Call (Service Oriented Framework and API for SDV)

[14] HEU-CL5-2024 (Horizon Europe Cluster 5 Workprogramme 2024) D6-01-01 "Centralised, reliable, cyber-secure & upgradable invehicle electronic control architectures for CCAM connected to the cloud-edge continuum"
To be confirmed: HEU-CCAM-2025/2027 (Horizon Europe Cluster 5 Workprogramme 2025 and/or 2027) "Integration of SDVoF building blocks in CCAM applications and test in real world traffic"

Calls in the 2Zero program[15] are planned to pilot the usage of the emerging SDV framework in vehicles for CO_2-free mobility. CCAM and 2ZERO calls concentrate mainly on the usage of the middleware building blocks in vehicle applications.

Planned work in area "Supporting Tools and Toolchain"

Highly-automated engineering methods, tools, and tool-chains shall help to improve the efficiency, productivity, quality, and dependability of the engineering process for automotive ADAS, AD, infotainment, sensing, and control systems. The engineering process support should rely on existing (open-source) solutions wherever possible, extended and/or complemented by newly developed methods, toolchains, and tools when required. Building blocks are encouraged to be open-source wherever adequate. The software development and maintenance tools shall improve the productivity and support the SDV SW stack DevOps lifecycle. The use of AI and generative AI will give an added important boost in productivity.

A project from the 2Zero[16] program will start in 2025 and contribute methods and tool-building blocks. The project selected from the HORIZON-Chips 2024-1-IA-T3[17] call will also contribute to this phase. A larger project is suggested by the SDV-SGG for the HORIZON-Chips-JU call 2025 working on (generative-)AI enhanced design and engineering tools envisaged to start in 2026.

Planned work in phase Maturing structure and SW stack

In the second phase of the initiative, the focus will be on maturing the structure and the building blocks of the SDVoF SW stack as described on page 18. The results of the initiative will be continuously improved and extended. It is also envisioned, that a new or existing organization(s) will take over the results of the initiative and form and support industrialized automotive grade SDV SW-Stacks. A dedicated call is suggested by the SDV-SGG for HORIZON-Chips-JU call 2026 to support this phase. In this project also the results of the sister initiative will be combined with the SDVoF results.

Coordination and support actions for the Initiative

The HORIZON-KDT-JU Coordination and Support Action (CSA) FEDERATE started end of 2023 to support and foster the European SDVoF community and partnership between EC and industry, research, the Open-source communities, and public funding agencies. FEDERATE provisions orchestration of SDV Research, development, and innovation activities across Member States, and organizes and hosts technical discussion panels (concept, glossary, high-level use-cases and requirements) and strategic alignment (vision, roadmap, research calls and activities). These activities shall be continued either by a follow-up Coordination and Support Action or by an association or similar entity (as described on page 18) taking over these activities from FEDERATE.

[15] HORIZON-CL5-2024 (Horizon Europe Cluster 5 Workprogramme 2024) D5-01-05: "Advanced digital development tools to accelerate the development of software defined vehicles that enable zero-emission mobility (2ZERO)"
To be confirmed: HEU-2ZERO-2025 (Horizon Europe Cluster 5 Workprogramme 2025) "Piloting the emerg.SDV framew.for optim.energy usage in EVs embedded in the energy infrastructure"

[16] HORIZON-CL5-2024 (Horizon Europe Cluster 5 Workprogramme 2024) D5-01-05: "Advanced digital development tools to accelerate the development of software defined vehicles that enable zero-emission mobility (2ZERO)"

[17] HORIZON-Chips-2024 Work programme 2024 (Non-initiative part) 1-IA T2 Focus topic on "Service Oriented Framework for the Software Defined Vehicle of the future"

Planned project in the sister initiative "High-Performance Automotive RISC-V Reference Platform"

Scalable automotive processors, spanning from cost-efficient, real-time control to high-performance super-scalar application processors and hardware accelerators shall be developed for the automotive market, based on the RISC-V family in a project called the HORIZON-Chips-2024 program. It shall support hardware abstraction and virtualization of the SDV concept and facilitate certification according to automotive safety and security standards. Instruction and data level parallelism (super-scalar and vector instructions), fast context switching, and accelerators support are needed to satisfy performance needs of complex AI/ML applications. A project proposal is supposed to be selected in the call HORIZON-Chips-JU 2024 [18]. The mentioned project is part of the roadmap for the sister initiative[19]. The RISC-V Scaler joint-venture founded in 2023 supports the sister-initiative on RISC-V HW.

It aims to develop an ecosystem for RISC-V inspired by the ARM ecosystem handling licensing, toolchain support, updates etc. Its Initial application focus will be automotive.

Support of the successful uptake of SDVoF results in European vehicles

As indicated above, the private public partnerships CCAM and 2ZERO have also indicated their support of the SDVoF initiative. Alignment meetings between SDVoF and the 2 partnerships are on-going. CCAM and 2ZERO will also support in their co-programmed calls the adoption of the SDV building blocks and tools for in cooperative, connected and automated mobility (CCAM partnership) and for electrified vehicles in CO2 neutral mobility (2ZERO partnership), as well as the piloting of the operation in the relevant infrastructures.

4.2 Proof-of-concepts by implementation of real application use-cases

A set of high-level application use-cases (UC) is suggested to prove at early stages of the initiative, that the building blocks can be successfully used in automotive products. Some of the application use-cases will additionally serve as proof-of-concepts (PoC) for the successful implementation of the principles described in section 2.2. The application use-cases will also help to identify building blocks and allow their validation. This resembles a powerful tool to check if all goals of the initiative are achieved.

Table 1 lists use-cases as discussed in the SDVoF Sherpa Governance Group.

[18] HORIZON-Chips-2024 Work programme 2024 (Non-initiative part) 1-IA T2 Focus topic on "High Performance RISC-V Automotive Processors supporting SDV"

[19] Report "High Performance RISC-V Automotive Processors supporting the vehicle of the future" prepared by the European RISC-V working group, draft version Feb 9th, 2024.

Table 1: Agreed use-cases

Application Use-cases (UC)	Description of UC
Plug & Charge (also bi-directional) and Open-Source UC	Plug and charge including in the medium term also bi-directional charging. Usage of secure and stable open-source with automotive grade in company specific SDV SW Stacks.
ADAS HW Platform replacement UC	HW-System abstraction, which allows replacement of HW platform (e.g. supporting shared sensors) with no or only little changes to application SW.
Chassis domain (vehicle motion control) UC	Vehicle motion control. The description will be refined throughout the initiative.
Cockpit user experience (hypervisor) UC	Common execution environment for user experience, this use-case shall also demonstrate user experience in a hypervisor architecture.
Shared Sensor ADAS/AD – Cockpit UC	Cross-domain, e.g. cameras for several apps supporting multiple features within the car (e.g. ADAS and cockpit) and being interoperable between different app stores beyond Google Play.
Collaborative SW Development UC	Collaborative (multi-firm) DevOps tool chain, demonstrating critical SW updates from code to car in a week instead of months.

Table 1 will be updated during the SDVoF projects duration. Several additional use-cases candidates will be collected but need further refinement. The current list is shown in Table 2.

Table 2: List of potential use-cases, to be further discussed

Potential additional application UC collected so far	Description of UC
Service Orchestration UC	Demonstrate secure orchestration of in-vehicle functionalities with cloud services from multiple domains (also OTA), e.g., building automation and infrastructure services.
Cyber-security Incidence Response UC	Demonstrate anomaly detection and tool support for fast identification and analysis of cybersecurity vulnerabilities and exploits, as well as fast patching, across different vehicle types and makes.

The use-cases will be demonstrated by at least two OEMs or at least two Tier1s in projects of the SDVoF initiative and prove the successful implementation of the goals of the initiative. Several use-cases will require a cooperation between projects and thereby span across two or more projects, working on different building blocks of a SDV SW stack as well as the integration into vehicles SW stacks also integrating the results of the sister initiative on automotive RISC-V.

4.3 Roadmap for conferences to foster the SDVoF eco-system

SDVoF themed conferences and community building activities foster strong and efficient collaboration between industry, research, scholars, and Open source in Europe and beyond. The CSA FEDERATE will organize such events and activities, both strategic and research/engineering focused. This will be arranged in collaboration with European Automotive industry associations (e.g. VDA, PFA, ANFIA) and relevant industry initiatives as Eclipse SDV, SOAFEE, AUTOSAR, and COVESA. First workshops and sessions will take place in 2024 in co-location with two established events allowing fast ramp-up and involvement of established communities.

Also in future, Federate will organize every year two main events: an ecosystem event for management level and an ecosystem event for SDV software developers. Whenever possible, these events will be co-located or co-organized with events from the partner initiatives.

In 2024, these events will take place in cooperation with The Autonomous Event (Vienna) and the Eclipse-OCX Conference (Mainz):

- **SDVoF Ecosystem Networking event with a strategic focus**, collocated with The Autonomous conference in **Vienna (Sep 24 – 25, 2024):**
  Focus on strategic topics: Day 1 will bring together project managers and experts from the SDVoF running and proposed projects (HAL4SDV, proposal on call-2024) and partner initiatives of SDVoF (AUTOSAR, COVESA, SOAFEE, ECLIPSE-SDV, CCAM, 2ZERO in Vienna to exchange information, share and sharpen vision and work on a joint functional structure. At the second day, 3 specific program topics in The Autonomous conference will focus on the European impact of the SDVoF initiative from a strategic perspective from high level industrial and political leaders of the ecosystem.

- **SDVoF Ecosystem Networking event with a developer focus**, co-organized with Eclipse-SDV: OCX (Open Code Experience) in **Mainz (Oct 21 – 23, 2024):**

  Developers will share information about on-going and planned work on building blocks in the first SDVoF project HAL4SDV, the ongoing projects in Eclipse-SDV, and use the opportunity for alignments.