



SAP Open Source

2022 Year in Review

THE BEST RUN



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In this yearly report, we would like to share news regarding SAP's open-source activities and engagement in 2022. Find highlights related to some popular SAP-initiated open-source projects, and a list of new projects such as the Node.js GraphQL adapter, which is the beginning of the open-source journey of the SAP Cloud Application Programming Model (aka CAP).

You can read about SAP's collaboration with open-source foundations and organizations, as well as about new open-source management tools, services, and security offerings used in our development organization. Find out more about SAP's OpenChain certification and the new internal global policy for open source. You will also learn about how InnerSource is gaining momentum.

All these achievements were the joint effort of many. We would like to thank all teams and individual contributors for their engagement with open source and for providing input for this report and we encourage you to find open-source projects to use, share, or contribute to.

1. CONTRIBUTIONS TO OPEN SOURCE

While we use open source to innovate and provide our customers with the best solutions, we also share code with our external ecosystem and believe in the strength of healthy open-source communities. The [Open Source Contributor Index](#) is a good indicator of how companies engage with external open-source communities. According to the latest numbers, SAP is among the top 10 commercial organizations world-wide with considerable growth in both active contributors and casual committers.

PROJECT HIGHLIGHTS 2022

The following report will provide you with an overview of the many open-source contributions by SAP teams and employees over the past year. We will provide a featured list of the new projects that have been published by SAP as open-source repositories on [SAP GitHub.com](#) this year. You will also find insights into the improvements facilitated by the SAP Open Source Program Office (OSPO), and the related teams, that are simplifying and fostering open-source contributions.

SAP Cloud Application Programming Model Goes Open Source

The SAP Cloud Application Programming Model (aka CAP) is a key pillar for professional development of enterprise-grade, cloud-native business applications on SAP Business Technology Platform (BTP) and the foundation for low-code development with the SAP Business Application Studio ([read more](#)). [Sample applications](#) for the SAP Cloud Application Programming Model have already been open sourced since 2019. This year in November, at TechEd Las Vegas, the new [GraphQL adapter for Node.js](#) was open sourced and more components of "CAP" will follow in 2023, such as the documentation, the CDS Type Generator for JavaScript, PostgreSQL, and more. Read more in this [blog post](#).

Open Documentation Initiative

The [Open Documentation Initiative](#) was launched in 2021 to use GitHub to collaborate with users and collect feedback on SAP developer documentation (published on [SAP Help Portal](#)). First time contributors need to sign the Contributor License Agreement (CLA) in GitHub and familiarize themselves with the [contribution guidelines](#).

This year, more than 10 repositories were created to support this new collaboration approach for SAP frameworks and services such as [sapui5](#), [btp-identity-authentication](#), and [btp-integration-suite](#). The team created a quick [survey](#) (open until end of January 2023) to fine-tune the initiative.

Read one of the blog posts tagged with [#open-documentation-initiative](#) to learn more about it.



Gardener ([GitHub](#)) is an SAP-driven open-source project that delivers fully managed Kubernetes clusters at scale across any cloud provider as your own Kubernetes-as-a-Service.

In the past months, the team has released support for ARM CPU architecture-based virtual machines. Gardener can now run production workloads on virtual machines using instances that are based on this architecture. You can run these workloads by adding a worker pool to a shoot cluster with the ARM CPU architecture.

Gardener now also offers capabilities for automated Kubernetes certificate authority (CA) and credential rotation with no downtime for the workload running on the clusters. For more information, see [Credentials Rotation For Shoot Clusters](#). To give you an idea of the magnitude of this feature, you can have a look at the [GitHub issue](#) and its 101 subtasks. If you want to find out more about the Gardener project, visit <https://gardener.cloud/>.



Garden Linux ([GitHub](#)) is a Debian Linux derivative specifically designed for Kubernetes clusters (not limited to Gardener) optimized for a small footprint, reducing attack vectors, and increasing its own security and stability. Unlike most commercial distributions, Garden Linux uses the latest LTS Linux kernel. Garden Linux works as the foundation of thousands of Gardener clusters with a massive amount of worker nodes on the major hyperscalers.

The [secure boot](#) feature and [dm-verity functionality](#) are included and can be used at the user's discretion. There is a [guide](#) on how to use secure boot on AWS. Most of the Garden Linux build pipeline is now running on GitHub actions to make the build process more open and transparent. Security patches have been backported to the Garden Linux Kernel to ensure faster response times for critical CVEs. The 5.15 Garden Linux kernel comes with included support for Intel DFL FPGA drivers.



SapMachine ([GitHub](#)) is an [OpenJDK](#) release maintained and supported by SAP. The SapMachine team continues to be one of the top three contributors to OpenJDK releases 18 and 19. The focus of the contributions were optimizations for memory footprint and serviceability. Furthermore, the team maintained the OpenJDK port to IBM's Power architecture and the OpenJDK 11 and 17 update releases in 2022.

SapMachine binaries have reached a total of more than 8.3 million downloads via GitHub (including pre-releases), over 1.7 million downloads of the official SapMachine Docker image and more than 100 K installations of SapMachine on SAP desktop PCs/laptops. Quarterly security updates for three active releases and six supported platforms resulted in 72 shipments. Throughout the year, support for the Linux/AArch64 architecture was added.

The SapMachine team also worked on supportability tooling. One achievement is the ap-loader tool, which wraps Async Profiler in a platform independent way and makes it easier to consume ([read more](#)). If you want to learn what SapMachine is, how it came to be and evolved, and why SAP contributes to the OpenJDK, you can listen to our [podcast episode](#).



OpenUI5 ([GitHub](#)) is an open-source project that provides a JavaScript UI framework and a set of UI control libraries for developing enterprise-grade web applications. In 2022, development efforts were focused mainly on expanding the support for [TypeScript](#) and enabling the usage of Web Components natively ([read more](#)) with the UI5 programming model. This reflects the way forward to align the framework with the latest web standards and trends.

To bring resources together and strengthen the bonds to the UI5 community, SAP took the opportunity to sponsor the open-source development of [wdi5](#) ([GitHub](#)), an end-to-end test tool for UI5 applications. The move of the project into the UI5 Community ([GitHub](#)) completed the release of the first major version of wdi5 in late November 2022. In a joint effort, SAP and the UI5 Community drew up and adapted guidelines for developing UI5 generators as plug-ins for the Easy-UI5 Generator

([GitHub](#)) to make them work hand in hand and ensure that they can be easily integrated into the official UI5 development toolchain. With [Best of UI5](#), the UI5 Community established a new entry page where people can share and find libraries and tools for UI5.

In July 2022, [UI5con](#) took place for the seventh year in a row. After two purely virtual events in 2020/21, this year the 2-day event was held in a hybrid format with around 100 participants onsite and more than 1,500 viewers from all over the world watching [UI5con hybrid 2022](#) online. In addition, the free webinar series, UI5ers live, was continued in 2022, with exciting panelists from SAP and the UI5 Community who shared projects and talked about what's new in UI5. Have a look at the [event page](#) for past and upcoming sessions.



UI5 Web Components ([GitHub](#)) are lightweight, self-contained, enterprise-ready UI elements based on the [Web Components](#) standards. They come with a minimal footprint and can be integrated with any UI framework, such as React, Angular, Vue, or plain HTML.

In 2022, the focus was on collaboration with the OpenUI5 project to provide wrappers to utilize UI5 Web Components with the UI5 programming model, whilst at the same time the team continued to work on improving the library and providing new components. Another important achievement was the implementation of the new Horizon family themes (Morning Horizon, Evening Horizon, High Contrast White/Black) in all components. In January, team members were invited by the creators of [Vaadin](#) — an open-source *web application* development platform for Java including Web Components — for a [panel discussion](#) on “Building accessible design systems with web components” together with experts from IBM, ING, and Adobe.



Kyma ([GitHub](#)) is the opinionated layer on top of Kubernetes that enables you to build secure enterprise-grade applications that follow industry best practices. 2022 has been a year of change for Kyma. The team rewrote how Kyma is installed and managed and made it much more robust and scalable.

The focus was on executing the Kyma strategy and replacing weak links in the observability capabilities with integration into enterprise-grade scalable solutions. You can read more about these efforts in this [blog post](#). Work on improving Kyma's robustness and scalability by moving to a Kubernetes native approach to manage the individual Kyma components continued in 2022. You can get more details about our modularization efforts [here](#). The dashboard is now also customizable. You can find the details in the [Busola GitHub repo](#).



Spartacus ([GitHub](#)) is a lean, Angular-based, JavaScript web shop (storefront) designed specifically for SAP Commerce Cloud. We are happy to announce that Spartacus is now published as an official SAP product: SAP Commerce Cloud, composable storefront. The official release is only for cloud customers, but because Spartacus open source remains synchronized with the official code base, on-premise customers can still use the open source for their projects. With the May 2022 announcement that the older Accelerator storefront templates are deprecated, Spartacus is more important than ever to the success of SAP's commerce platform. Upcoming plans include achieving parity with Accelerator features, continued improvements in architecture, and scaling up and out the number of teams and developers enabled in adding features.



Fundamental ([GitHub](#)) is an open-source and community-driven project for providing a consistent user interface across web applications. Fundamental Library offers enterprise qualities, like theming and accessibility, to further support front-end developers. The library has counted more than 6.5 million npm downloads since it was first introduced. In the first part of the year, the team successfully incorporated the new modern Horizon design theme. The latest versions of both the [Fundamental Library Styles](#) and [Fundamental Library NGX](#) include the four Horizon family themes: Morning Horizon, Evening Horizon, High Contrast White, High Contrast Black.

In September, the Fundamental Library team organized the second [Fundamental Conference](#) where 19 speakers from 7 different countries delivered 14 different sessions covering topics in design, accessibility, and development. Recently, the team introduced new packages (CX, FN, Common-CSS) to support SAP teams such as Customer Experience and BTP, as well as to provide its users with new components and designs. As part of its ongoing release cycle, the team continues to deliver new components for Fundamental NGX and Styles aligned with the SAP Design System.



Luigi ([GitHub](#)) is an enterprise-ready micro frontend [framework](#) for building modularizable, extensible, scalable, and consistent administration and business user interfaces and web applications. With its global open-source community growing on every channel, the number of npm downloads for the client package has increased by 40% compared to the same period last year. The team released many new features, especially around support for web components and design system updates (Horizon themes). There was also a lot of effort that went into Luigi's new additional lightweight approach to integrate micro frontends into existing applications, luigi-container, which is planned to be released in Q1 next year and completes Luigi's offering for such scenarios.



Code Pal for ABAP ([GitHub](#)) is an engine that is fully integrated into ABAP development tools and frameworks. It provides a comprehensive set of ABAP Test Cockpit (ATC) checks that supports developers in writing high quality, clean ABAP code.

In 2022, the development efforts were focused mainly on the stabilization of Code Pal to further strengthen the adoption of the tool in the community. This lays the foundation for the upcoming major improvements in 2023 concerning the availability of Code Pal in the cloud, including quick fixes for semi-automated adaptation of custom code for Clean ABAP principles.



Project "Piper" ([GitHub](#)) is an open-source project offering ready-made pipelines to easily set up continuous delivery in projects using SAP technologies. In customer installations, project "Piper" is used in more than 7,500 builds per day, with constant usage.

In 2022, the team added steps to upload content to AWS or Azure Storage buckets. In addition, an integration for BTP Alert Notification Service was added. Once activated, all log entries are forwarded to the BTP Alert Notification Service and with a dedicated step you can send custom messages. With the new feature for the SAP BTP ABAP environment, it is now possible to include ABAP Unit tests in your CI/CD pipeline with ABAP Unit as the standard tool to write unit tests in the ABAP language and ensure high code quality. Learn more from a recent [webinar recording](#) with Thorsten Duda, Product Owner for the Continuous Integration and Delivery Service and contributor to project "Piper" at SAP. Or listen to the [podcast](#) episode about project "Piper", with Christoph Szymanski, Service Owner for SAP's Continuous Integration and Delivery service, published on December 28th (2022).



The Corona-Warn-App (CWA) is an app that helps to trace and stop infection chains of SARS-CoV-2 in Germany. It is based on a decentralized approach and notifies users if they have been exposed to the virus. By now, this app has been downloaded over 47 million times, has managed over 231 million PCR and rapid antigen tests, and delivered more than 219 million warnings to break infection chains.

Since its initial release, 45 releases have been published with a rich set of new features. The app gained adoption during the pandemic with features extending beyond the pure contact-tracing app to the development of cluster-event detection, contact diary, and certification management. Release cycles in 2022 slowed down as the app reached a feature-complete and stable status where no more critical bugs were identified. Now with release 3.0 a new major version will be released soon which will allow users to warn others based on self-tests (i.e., without official test results).

This success would not have been possible without the numerous contributions of the open-source community and shows how active community engagement and management pays off. Moreover, CWA also was recognized with the [iF Design Award](#), the [UX Design Award](#), the [Red Dot award](#), the [ADC recognition for modern design](#), and the [Stevie Award](#) for most valuable COVID-19 product. These awards reflect SAP's capability to deliver open-source solutions with modern and effective user experience in collaboration with the open-source community.

Examples of New SAP Projects Open Sourced in 2022 on SAP github.com

The following list provides some examples of projects that went through the SAP outbound process in 2022 and are now available on SAP's GitHub organization.

- [risk-explorer-for-software-supply-chains](#) was published in early 2022 by SAP in collaboration with the [University of Rennes 1](#). This project helps to explore the security risks for software supply chains by visualizing a taxonomy of known attacks and techniques to inject malicious code into open-source software projects.
- [open-ux-odata](#) provides a collection of utilities for the OData protocol that can be used in different applications. Both projects, [open UX tools](#) and [open UX odata](#), aim to provide open-source modules that make the development of SAP Fiori applications more efficient. The main goal of the open-UX projects is to collaborate with the community to create transparency and therefore increase the adoption of the relevant tools.
- [guided-answer-extension](#) is a new tool in SAP Business Application Studio and VSCode that provides a simple interactive way to show developers how to troubleshoot issues and navigate processes, by guiding them through tasks published in [SAP's Guided Answers](#). Its purpose is to enable community collaboration to jointly promote and develop a VSCode extension. In just about 5 months, the Guided Answers extension was downloaded more than 30k times with steady growth. Read more in this recent [blog post](#) about the SAP Fiori tools 2211 update.
- [e-mobility-charging-stations-simulator](#) is easy-to-use node.js software for simulating and scaling a set of charging stations based on the OCPP-J 1.6 protocol as part of SAP's e-Mobility solution.
- [wdio-qmate-service](#) is a service that helps writing tests for web applications and APIs. It is based on WebdriverIO which was adapted to provide customized services specifically tailored to UI5, but can be used on any other browser-based application as well.
- [SAP Commerce DB Sync](#) performs table-to-table replication in a single-directional manner between two SAP Commerce instances (on-premise to cloud) or between SAP Commerce and an external database. Synchronizing with an external database is key to integrating SAP Commerce Cloud with SAP Analytics Cloud or other analytics solutions for reporting purposes.
- [Curated Resources for Domain-Driven Design](#) is a GitHub repository that contains curated resources and best practices on the topic of Domain Driven Design (DDD) and Event Storming, that we recommend internally at SAP and are happy to share with the community. This project is testament to the commitment of SAP to DDD ([read more](#)).

Examples of SAP Contributions to Open-Source Projects

In this section, we provide some examples of SAP teams and developers collaborating with open source-communities and contributing to open-source projects to benefit from the joint efforts, different views, requirements, and diverse backgrounds of the community members.

- **Rust:** The SAP internal [Rust](#) community is happy to welcome [Signavio](#) to the SAP family. Important parts of their technology stack are written in Rust. In 2022, more and more SAP departments started looking into Rust, which had a positive impact on the internal Rust community. Joint efforts to improve the language led to contributions ranging from comments and GitHub issues to actual code contributions. New Rust projects have also been kicked off. The most

notable contributions have been made to the following projects: [Rust language](#), [arrow-rs](#), [Parquet2](#), [openraft](#), [hdbconnect](#), and [flexi_logger](#).

- **Metaflow-Argo Workflow:** The [Metaflow-Argo Workflow](#) integration, which was originally started by SAP, is a great example of collaboration in the open-source communities to jointly drive innovation in AI and Data Science. Read more in this recent [blog post](#) by SAP about how to use the new Metaflow-Argo plugin together with SAP AI Core.

Another example for SAP's contributions to [Argo Workflow](#) comes from the AI Workbench team. They added the support of HTTP input/output artifacts via the webhdfs protocol. This enables Argo Workflow to work with HANA Datalake.

- **Gerrit Code Review, Eclipse JGit:** [Gerrit Code Review](#) was started by Google to support their large open-source projects (Android, Chromium, Golang, etc.) with a Git-based code review tool providing a similar commit-centric code-review model as the proprietary [Critique](#) which is used at Google to review changes in their huge mono-repo. At SAP, Gerrit has been used internally since 2011 by thousands of developers and is the basis of the BTP Git Service. SAP's Git team has been contributing to Gerrit since 2010 to ensure it meets SAP's requirements, it has 3 maintainers out of 23 in the Gerrit project and serves on its Engineering Steering Committee overseeing the architecture and roadmap of the project ([read more](#)). More than 100 developers from many organizations contribute to Gerrit on a regular basis.

Currently the SAP Git team is focusing on developing a [Kubernetes deployment of Gerrit](#) to improve resilience and cost efficiency and improve performance and scalability, especially for large mono-repos like the one used by the SAP HANA team.

Gerrit is based on [Eclipse JGit](#), the popular Java implementation of Git (>7 million downloads per month from Maven Central). SAP's Git team has been contributing since 2009 and has 2 maintainers and the project lead in the JGit project ([read more](#)). Their focus is on bug fixing, performance and scalability improvements, and reviewing contributions from other contributors.

- **Cloud Robotics Project:** Human-safe collaborative robots (Cobots) and Automated Guided Vehicles (AGVs) are being increasingly used in shop floors, warehouses, or other environments where intelligent devices with sensors can support employees and enable new ways to execute process tasks automatically. To integrate such fleets of robots into business processes, SAP has been working with Google on a [cloud robotics project](#) to integrate any robot type into the processes of Extended Warehouse Management (EWM). Kubernetes APIs are leveraged to keep Cobots and AGVs in sync, and to make sure that tasks are being processed properly, even with intermittent connectivity.
- **Eclipse Vert.x:** [Vert.x](#), a lightweight event-driven, and non-blocking application framework, is used in many applications and is very popular for performance-oriented use cases with very high degrees of concurrency like IoT. At SAP, Vert.x modules are being used in several applications and improvements and bug fixes have been contributed to packages like Vert.x-core, Vert.x-Web, Vert.x-JSON Schema, and Vert.x OPEN API.

Outbound Open-Source Quality Assurance

The Open Source Program Office (OSPO) supports SAP development teams in contributing to open source and engaging with open-source communities while at the same time mitigating potential associated risks. Open-source quality assurance and policy compliance is therefore a central component of our work.

Since 2022, SAP open-source projects are supposed to apply [GitHub's security code scanning](#) for their repositories in addition to the mandatory scans and quality checks (for instance, license checks). Mandatory, continuous license code scans for SAP open-source projects and their components have been further automated. This allows the OSPO team to react much faster to potential license compliance issues. Also, the processing times for new outbound open-source project requests were

shortened as the same functionality is reused during the incubation process of new SAP open-source projects.

Ultimately, some open-source projects reach the end of their lifetime and are no longer actively maintained. No matter the reasons that lead to projects finally being abandoned, it is important to also consider such situations in our quality assurance initiatives. Therefore, we introduced an automated check for stale projects. If an SAP open-source project hasn't shown any activity within the last two years, the team administrators are asked if the project should be archived or if they want to continue maintaining it. That ensures that we cover the complete project lifecycle in our processes and tools.

GitHub Organization Consolidation

Historically, several SAP teams have been publishing open-source software in their own GitHub organizations with their own policies and guidelines. In 2022, the SAP OSPO unified all these policies and guidelines by releasing a new global SAP open-source policy that is legally binding for all SAP employees and subsidiaries world-wide. The OSPO then aligned the different GitHub organizations that are owned by SAP and its subsidiaries and helped those teams to make the existing repositories compliant with the new SAP global open-source policy (read more in [chapter 4](#)).

REUSE Tool Support for ClearlyDefined

[ClearlyDefined](#) has been a vital tool for the management of copyright and license metadata for open-source projects in many different organizations and companies, including SAP, for a long time. The same is true for the [REUSE tool](#) by the Free Software Foundation Europe. It makes it easy for project maintainers to define the copyright and license information for each individual file in their repositories. While SAP has provided REUSE-compliant metadata for all our open-source projects for some years now, this information has not been evaluated by ClearlyDefined so far. Consequently, some license and copyright information of REUSE-compliant projects couldn't be used by ClearlyDefined, leading to missing information in ClearlyDefined and a bad overall rating.

But now this has changed. We have contributed the REUSE tool integration to ClearlyDefined ([crawler](#), [service](#)) and it was merged in H1/2022. This has led to significant [score improvements](#) for all REUSE-compliant open-source projects.

Metadata Creation Tool for REUSE

In addition to the ClearlyDefined contribution, we are also supporting the REUSE ecosystem with another open-source project, called the [Metadata Creation Tool for REUSE](#). This tool automatically creates the REUSE metadata files (dep5, licenses) depending on the declared licenses in an existing repository. This functionality is particularly important to those projects that apply [vendoring](#) in their repositories – mainly used in the Golang ecosystem. Previously, project maintainers needed to compile the license and copyright information manually, which could become very cumbersome and time-consuming.

Open-Source Project Incubation Powered by GitHub Probot

Several years ago, we implemented our open-source project incubation process (aka “outbound”) completely based on GitHub. However, the OSPO team members still needed to create all issues and steps manually. Already back in 2021 we started implementing many process steps and workflows in a [Probot-based GitHub app](#), which we extended in 2022. With this effort, we reduced the manual work of OSPO team members, which also reduced the overall time spent from the initial outbound open-source project creation request to the final publication.

2. FOUNDATIONS AND PARTNERSHIPS

SAP is an active member of, and contributor to, numerous open-source foundations and open-standards organizations. In this section, you will learn about some of our collaboration activities in working groups and joint deliverables with several of these organizations in 2022.

SAP Engagement in Foundations

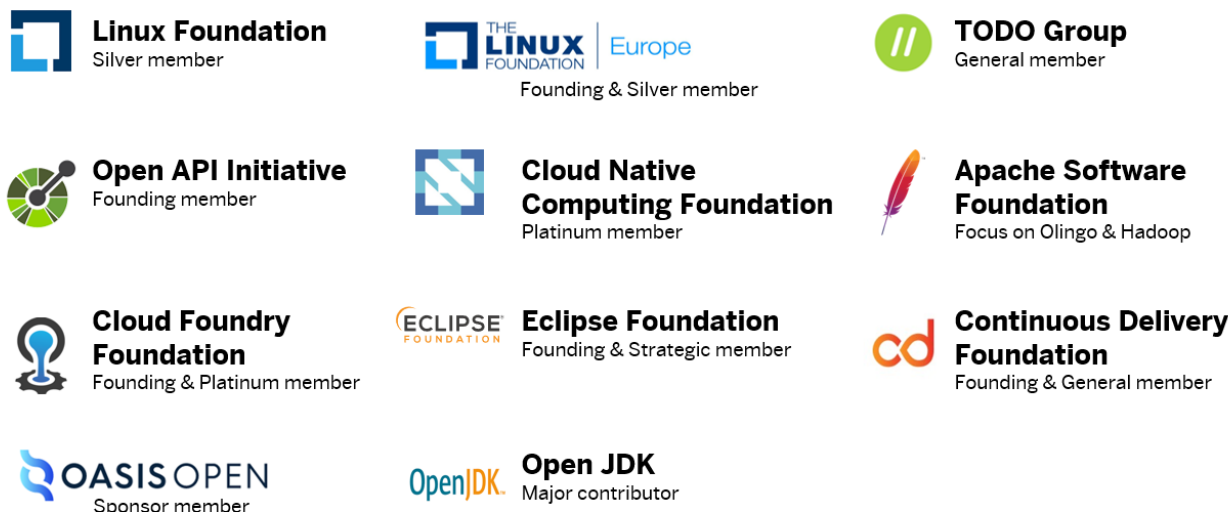


Figure 1 - SAP memberships in open-source foundations in 2022

Eclipse Foundation

SAP is a founding, strategic member of the [Eclipse Foundation](#) initiated in 2004. Traditionally, it is the home of Eclipse IDE and many developer tools. In the last decade, open-source projects from many other domains joined the Eclipse Foundation under the umbrella of [Eclipse Working Groups](#). Examples are the [IoT](#) (Internet of Things, Industry 4.0), [Edge Native](#) (open source platforms for Edge Native applications), [JakartaEE](#) (cloud-native Enterprise Java, successor of J2EE), [Adoptium](#) (open builds of OpenJDK) and [MicroProfile](#) (Enterprise Java for microservices) working groups. SAP is currently a member of the IoT and the Eclipse IDE working groups.

The [Eclipse Foundation](#) moved from US to Brussels, Europe in 2021 supported by SAP and other founding members. This attracted many European organizations to join the Eclipse Foundation, for example, in the new Software Defined Vehicles [working group](#). In the meantime, more than half of the Eclipse Foundation's staff are based in Europe demonstrating that the move to Europe is strategic.

In October 2022, the Eclipse community met in Ludwigsburg, Germany at [EclipseCon](#) with many sessions, hackathons, and community meetings for IoT and Edge, Adoptium, the new Software Defined Vehicle working group, and more. SAP gave a presentation together with IDTA on digital twins and the Asset Administration Shell ([YouTube](#), [LinkedIn](#)).

In the next sections you will read about the Catena-X and IDTA, organizations, which collaborate tightly with the Eclipse Foundation and have their open-source projects managed by the Eclipse Foundation.

Catena-X

SAP is one of the founders of the [Catena-X](#) consortium, which is building the first open and collaborative data ecosystem for the automotive value chain based on [Gaia-X](#) principles. Besides SAP's contribution of commercial solutions into Catena-X for use cases such as sustainability, material traceability, and demand and capacity management, we are also involved in defining open-source core components, conceptualizing DevOps operations and contributing to the Eclipse Dataspace Connector as well as digital twin concepts based on the [Industrial Digital Twin Association](#).

SAP is an official contributor and committer to the [Eclipse Dataspace Connector](#), an open-source project that aims to provide a framework for sovereign, inter-organizational data exchanges within any federated network.

Based on this, the [Product Eclipse Dataspace Connector](#) open-source project (Product EDC) provides additional specific extensions for Catena-X as the first instance of a Gaia-X and IDS-A-compliant network. The Product EDC plans to move into the Eclipse Tractus-X environment at the beginning of 2023. SAP has mainly contributed extensions for authentication, authorization, and audit logging. Furthermore, SAP is heavily involved in refining the concept for usage and access control, which is planned to be implemented in 2023 and will be an essential part of the EDC.

On the [DevOps tooling side of Catena-X](#), SAP provides significant expertise. Our experience in building modern, cloud-native solutions with open-source technologies like Kubernetes or argocd, and making small contributions to those projects inside SAP, allows us to bring this knowledge into open-source projects like Catena-X. Being part of the DevOps system team of Catena-X helps to provide a better platform architecture, as well as to drive open communication by way of office hours and public documentation.

Digital twin concepts are quite essential for the Catena-X data ecosystem. The Asset Administration Shell ([AAS](#)) has been defined as standard in Catena-X for management of digital twins. The defined semantic data models will be released under open-source license and Catena-X is also contributing to further enhance AAS functionality and standardization of submodels in open source.

Industrial Digital Twin Association

Together with major players in the industry, SAP is a founding member of the Industrial Digital Twin Association ([IDTA](#)). The IDTA drives the implementation and adoption of industrial digital twins based on the open-standard Asset Administration Shell ([AAS](#)) via open source. See the [AAS Reading Guide](#) to get access to more information about AAS concepts and specifications. SAP leads the activities to shape the open-source strategy at the IDTA. The IDTA is working together with the [Eclipse Foundation](#) to benefit from its expertise in driving successful open-source initiatives and co-innovation ecosystems.

The [Eclipse Digital Twin Top Level Project](#) hosts open-source projects establishing the AAS as a de facto standard for industrial digital twins. SAP has an active role in this top-level project as a member of the Project Management Committee (PMC). Additionally, SAP submitted the Eclipse AAS Model for Java ([AAS4J](#)) — an open-source implementation of the AAS Specification ([AAS Part 1 – Metamodel](#)) as reusable Java libraries that resulted from a co-innovation project with Fraunhofer Gesellschaft. Based on these Java libraries, different software components can build industrial digital twins based on AAS to be used in Industry 4.0 applications ([read more](#) in the technical article “Open Source Drives Digital Twin Adoption”).

IDSA – International Data Spaces Association

The International Data Spaces Association ([IDSA](#)) strives to enable business processes to work across companies and industries while ensuring self-determined control of data use (data sovereignty). SAP's contribution to specifications, architectures, and the application of [IDSA principles](#) to business processes ensures that IDSA aspects can be used in a compliant and scalable manner in enterprises.

Linux Foundation – Linux Foundation Europe

[Linux Foundation Europe](#) was launched in September 2022. Its mission is “to accelerate the growth of thriving open collaborative efforts focused on challenges and opportunities of all European constituencies, from individuals to public and private sectors, while providing an on-ramp for European projects and companies to succeed and collaborate on a global scale.” ([Source](#))

SAP is an inaugural member of this new foundation, which is headquartered in Brussels, Belgium and led by Gabriele Columbro as General Manager. A [press release](#) by the Linux Foundation Europe provides more details about the aims and inaugural members.

Vasu Chandrasekhara, member of the CNCF’s governing board, represented SAP at the Linux Foundation Open Source Summit in Dublin (September 13-16) as a featured speaker and panel participant ([link to session](#)).

Linux Foundation – Cloud Native Computing Foundation (CNCF)

The Cloud Native Computing Foundation ([CNCF](#)) is part of the Linux Foundation (LF). It hosts [open source projects](#) for globally used, cloud-native technology, such as [Kubernetes](#), [Knative](#), and more. SAP has been a Platinum Member since 2017. In line with this membership, SAP has a seat on the CNCF Governing Board, which, among other tasks, overlooks marketing and budget decisions for the CNCF.

[Flux](#), a popular project hosted by the CNCF, was voted into [graduation status](#) in November 2022. SAP teams are avid users of Flux, using it in the context of Git Driven Operations (cf. <https://opengitops.dev/>). The methodology and mindset have revolutionized the way modern cloud-native product/service teams run DevOps. Flux is a great example of how open-source communities can connect and enrich each other. The community of the SAP-initiated Gardener project also contributed a Flux integration. Another project that is in the process of graduation is [Argo](#), a workflow engine for Kubernetes, with contributions from a number of SAP teams (see chapter 1 [Examples of SAP Contributions to Open-Source Projects](#)).

[CloudEvents](#) is a specification for describing event data in a common way. By providing consistency and interoperability, it largely facilitates the exchange of events between systems, even across organizational boundaries. SAP has been contributing continuously to the CloudEvents project from its beginning. Meanwhile, SAP’s applications rely on CloudEvents for publishing events to customers and partners, leveraging the portability of CloudEvents across multiple protocols and infrastructures.

Linux Foundation – Cloud Foundry Foundation (CFF)

Cloud Foundry Foundation ([CFF](#)), hosted by the Linux Foundation, embraces the development of a Platform-as-a-Service (PaaS) open-source technology. As a platinum member, SAP assigns a representative to the Governing Board and two representatives to the Technical Oversight Committee (TOC). Additionally, SAP has technical leads, approvers, and reviewers in various [working groups](#). In 2022, SAP was the [second largest contributor](#) after VMware, with almost a quarter of the overall commits coming from SAP developers.

In 2022, SAP managed to increase its engagement in different working groups (WG) with community management and technical governance:

- SAP is now leading the [App Runtime Deployments WG](#) that is responsible for creating the community CF distribution.
- The [App Runtime Interfaces WG](#) is actively supporting projects such as CAPI (the CF APIs) or App Autoscaler. We increased the number of approvers for the CAPI project, and we are driving the development of new features for the App Autoscaler.
- In the [App Runtime Platform WG](#) we also increased the number of approvers and reviewers for the areas of application execution, ingress and app-to-app routing, and aggregation of application logs and metrics.

This year the CFF organized a [Cloud Foundry Day](#) as an event co-located to KubeCon North America in Detroit. All sessions were recorded, and the recordings are available in the [CFF YouTube channel](#). SAP hosted two sessions during the CF Day conference: one about [New Features in App Autoscaler](#) and a second session about the [Performance Improvements in the CF APIs](#).

If you want to hear more about Cloud Foundry and the latest news from the CFF community, check out the [podcast](#) episode with Ruben Koster (VMware) and Beyhan Veli (SAP), published at the end of September 2022.

Linux Foundation – TODO Group

The [TODO Group](#) of the Linux Foundation (a working group where the OSPOs of many companies come together to share best practices about the management of open source) published a [new guide](#) about outbound open source (describing how to contribute to and launch open-source projects) with SAP OSPO co-authoring the guide. As a next step, a training module is planned to be created based on the guide. Another [paper](#) was published in February 2022 talking about the evolution of Open Source Program Offices with SAP sharing some best-practices.

SAP LinuxLab

In 2022, the SAP LinuxLab founded a new [initiative](#) together with IBM, Red Hat, SUSE, and SVA to join forces for the creation of new open-source software with the goal to create and manage SAP landscapes more easily (read more in this [blog post](#)). By the end of 2022, there were around a [dozen repositories](#) providing tools and automation. The idea is to enable SAP (Service) Partners to enhance their software by reusing unified and modular code and tools in their products and offerings, helping to avoid common errors and to benefit from other partner's contributions. SAP customers will benefit from such open-source software and are encouraged to participate in the development of upcoming solutions. Although the initial contributions targeted SAP landscape management, upcoming projects are adding further tools such as a [bash command-line completion](#).

OASIS Open

SAP is a Sponsor Member of [OASIS Open](#), a non-profit standards body hosting open-source projects and open-standards initiatives around cybersecurity, blockchain, IoT, emergency management, cloud computing, legal data exchange, and much more. Its goal is “a path to standardization and de jure approval for reference in international policy and procurement.” ([Source](#))

SAP has participated in 18 Technical Committees (TC) over the last few years and is currently actively participating in the [OData TC](#). The goal is to simplify data sharing across disparate applications in enterprise, cloud, and mobile devices. The resulting standardized REST dialect is used in more than a thousand public SAP REST APIs. OData consists of several [Core](#) and [Extension](#) specifications, the latest addition being the [OData Extension for Temporal Data Version 4.0](#), published in 2022.

SAP is also sponsoring the [Baseline Protocol](#): an EEA Community Project for combining advances in cryptography, messaging, and blockchain, to deliver secure and private business processes at low cost via the public ‘Ethereum Mainnet’. Baseline is a part of [EEA Community Projects](#), an OASIS managed Open Project.

Bitkom

SAP closely collaborates in different open-source related forums, projects, and working groups with the German Bitkom, a Federal Association for IT, telecom, and new media. In 2022, the “Open Source” workgroup published a comprehensive rework of its open-source guide ([Bitkom Leitfaden Open Source 3.0](#)) with SAP co-authoring the new version, in particular the chapter about Open Source Program Offices. SAP also actively supported the [Open Source Monitor](#), an open-source survey to monitor the progress and engagement of German-speaking companies with open source, which was published in English in April. SAP contributed a case study about its outbound open-source process and tools to this document.

The yearly [Bitkom Forum Open Source](#) event took place in Erfurt as an onsite event (for the first time in three years) with SAP being part of the organization committee and contributing to setting up the [event](#). SAP's [outbound process](#) was presented in one of the sessions with best practices, including the mandatory use of the Free Software Foundation Europe's REUSE tool and the full automation of SAP's compliance rule checking for all open-source repositories.

3. MANAGING OPEN-SOURCE CONSUMPTION

In this chapter, you will hear about new tools for supporting our development teams to ensure license compliance when consuming open source. Read about SAP's OpenChain certification and what this standard means for SAP. Our new SAP global open-source policy provides our developers with rules and guidelines for the consumption of, and contribution to, open source in a compliant and secure way.

OpenChain Conformance

In March 2022, SAP finished its certification for [ISO/IEC 5230](#) conformance. As mentioned in the related [press release](#) this was “the first time an enterprise application software company has undergone whole entity conformance” meaning that SAP self-certified as an entire company. This international standard for license compliance within the open-source software supply chain, also known as [OpenChain Project](#) under the umbrella of the Linux Foundation, is a testament of the maturity of SAP's management of license compliance.

SAP's OpenChain certification strives to help in establishing trust and reliability among all the participants in open-source software supply chains.

Shane Coughlan, OpenChain General Manager at the Linux Foundation, and Peter Giese, Head of the SAP Open Source Program Office talked about key requirements for this certification and SAP's experience with OpenChain conformance in a public [webinar](#) in April. More information is provided in a recent [blog post](#) and a [podcast](#) with Shane Coughlan, published by SAP in October 2022.

SAP Global Open-Source Policy

The new SAP global open-source policy defines fundamental principles for working with open source. This includes a set of rules to be followed by all SAP employees when consuming open-source software or contributing to open source within or outside their SAP working context. The objective of this policy is to provide SAP developers and related roles with guidance on open source. It also helps employees to clarify in which cases they might act as a company employee and in which cases they act as a private person for interacting with SAP external open-source projects and communities. SAP needs to mitigate any risks associated with consuming or contributing to open source (OSS). A complementary, dedicated training session explains relevant details of the policy and how it affects SAP developers.

Fosstars

Free and Open-Source Software Ratings ([Fosstars](#)) is an open-source service provided by the SAP Phosphor team and supports developers with a security rating for open-source components. It summarizes criteria relevant for a 'healthy' open-source project, such as the development activity and quality assurance by the community. The Fosstars service is developed as InnerSource, however the core part of it is open source. Features of the open-source repositories offer a rating for open-source components based on several criteria.

In the most recent [release](#) of the Fosstars-rating-core, we added new features that improve the ratings by considering security tools specific to different programming languages such as Python, Golang, etc. We also enhanced the rating core to check if the project repositories contain any executable binaries.

4. EMPOWERING OUR DEVELOPERS AND COMMUNITIES

In 2022, the SAP OSPO continued joint efforts with SAP teams and individual topic experts to share best practices and discuss open-source topics with developers in the open-source community, and the internal and external SAP ecosystem. In addition, the SAP OSPO worked on internal enablement with condensed content overview by way of [cheat-sheets](#), detailed documentation on internal [wiki-pages](#) (links are internal) and public content in different formats such as [podcast episodes](#), [webinars](#), [blog posts](#), etc.

With the support of many colleagues, and in particular our SAP open-source [champions](#), we have widened our internal and external communities and reach.

New SAP ‘Open-Source Topic Community’ Page

Most of the content of the SAP open source [landing page](#) was moved into the SAP Community Network to have a single source of information especially for external developers, consultants, students, and SAP’s software users. On the new [SAP Open Source Topic Community](#) page you will find content to get help, learn, share ideas, and connect with others. This Open-Source Community Topic page contains information about featured projects and SAP’s engagement with foundations. We welcome you to join our open-source community page by subscribing to ‘open source’ to get updates on the latest blog posts, webinars, or other events. You can also ask questions related to open source.

SAP Open-Source Webinars

We continued with the public webinar series hosting external and internal experts, who discussed a wide variety of open-source topics. We alternated public webinars on a bi-monthly basis with internal webinars sharing best-practice and details on open-source projects, foundations, security, processes, and tools.

You can find recordings of the following sessions in the SAP open-source [webinar platform](#).

- “Navigating Open-Source Risk” with Dawn Foster, VMware
- “Open-Source License Compliance with OpenChain” with Shane Coughlan, Linux Foundation and Peter Giese, SAP
- “Gaia-X, Catena-X, International Data Spaces – Three Initiatives, One Goal” with Nemrude Verzano, SAP
- “Copyright and License Compliance in SAP open-source Projects” with Sebastian Wolf, SAP
- “SAP Open Source - What's in it for Students?” with Ulrike Fempel, SAP
- “Project Piper – From InnerSource to Open Source” with Thorsten Duda, SAP

Podcast Series ‘The Open Source Way’

Our podcast series ‘[The Open Source Way](#)’ is moderated by Karsten Hohage, who interviews different internal and external guests about a variety of open-source-related topics. We published a new episode on *openSAP* monthly, and all the episodes are available on Spotify, Apple Podcasts, TuneIn, and Google Podcasts.

Overview of this year’s episodes:

- [Episode 18](#): Eclipse Dirigible – An Open-Source Platform for End-To-End Rapid Development of Business Applications (Yordan Pavlov and Dragomir Anachkov, SAP)
- [Episode 19](#): Mercedes-Benz FOSS – Open Source in the Automotive Industry (Dr. Wolfgang Gehring and Dr. Christian Wege, Mercedes-Benz)
- [Episode 20](#): Gaia-X, Catena-X, International Data Spaces – Three Initiatives, One Goal (Nemrude Verzano, SAP)
- [Episode 21](#): Open Source at Microsoft – ClearlyDefined and Open-Source Supply Chain Security (Nell Shamrell-Harrington, Microsoft and Sebastian Wolf, SAP)

- [Episode 22](#): Open Source at VMware – Key Driver of Innovation (Dawn Foster, VMware)
- [Episode 23](#): wdi5 – UI5's open-source end-to-end Testing Framework (Volker Buzek, j&s-soft GmbH and Peter Muessig, SAP)
- [Episode 24](#): Cloud Foundry – A One-Size-Fits-All Solution for Application Development (Ruben Koster, VMware and Beyhan Veli, SAP)
- [Episode 25](#): Linux Foundation – Building Trust in Software Supply Chains (Shane Coughlan, Linux Foundation)
- [Episode 26](#): Red Hat – Distributor and Mediator in the Open-Source World (Arne Arnold, Red Hat)

Champions Network

In 2018, SAP's Open Source Program Office (OSPO) established the internal "Open-Source Champions" network. This global group of nominated open-source enthusiasts from SAP's major development hubs volunteers to support and empower development colleagues and managers in their respective locations to easily engage with open source.

In 2022, new champions were onboarded, and the network now consists of 15 open-source experts, a diverse group of open-source enthusiasts with different roles within the company located in all of SAP's major development locations. They have closely collaborated with the SAP Open Source Program Office on the roll-out of relevant content into their development organization, providing feedback, and acting as multipliers. Read more in this [blog post](#).

5. INNERSOURCE

While SAP is an avid supporter and user of open source, as well as a major contributor to open source, not all its projects are developed as open source. But in these cases, we strive to run the projects as InnerSource.

InnerSource is the practice of applying open-source methods and best practices for in-house software development. It aims to improve internal development processes based on the learnings from open-source collaboration styles. InnerSource promises important benefits, such as better software quality, better collaboration, increased reuse, and – as a result – higher development efficiency. Therefore, our goal is to systematically enable our teams to run their projects as InnerSource and for our developers to contribute to such projects where it makes sense.

In 2022, the OSPO team continued to lead and coordinate this topic with the internal InnerSource Initiative (internally also known as the CPA working group). One of the main achievements in 2022 was the planning and execution of the InnerSource Days - the first SAP-internal conference dedicated to InnerSource. The goal of this event was to raise awareness for the InnerSource methodology internally and to share experiences of InnerSource projects. The event hosted external speakers such as Danese Cooper, founder and chair of the [InnerSource Commons](#) Foundation.

SAP-internal documentation about InnerSource best-practices was widely extended in 2022. The concept of [InnerSource patterns](#) was adopted from InnerSource Commons. We use this approach to share best practices for SAP-specific InnerSource topics. "InnerSource and ABAP" (describing options to run ABAP projects with an InnerSource approach) was one of the first internal patterns that were created.

To better support the creation of InnerSource projects, template governance models and template repositories were created. Development teams can take these as a starting point and adjust them to their needs. The working group also provided guidance and mentoring to several teams and projects on the adoption of InnerSource. SAP continued to share its learnings with the community:

- Together with other companies, SAP founded the "InnerSource Club". In monthly meetings, the participants share best-practices and discuss questions around InnerSource.
- At the [InnerSource Commons Summit](#) in November, SAP shared their InnerSource learnings in a [presentation](#) "InnerSource is a marathon, not a sprint – the SAP Journey".

2022 – Year in Review

References

1. Open-Source Projects

- [SAP Cloud Application Programming Model blog post](#)
- [Open Documentation Initiative blog post](#)
- [Gardener GitHub](#), <https://gardener.cloud/>
- [Garden Linux GitHub](#)
- [SapMachine GitHub](#), [podcast](#)
- [OpenUI5 GitHub](#), [wdi5 GitHub](#), [UI5 Community GitHub](#), [Best of UI5](#)
- [UI5 Web Components GitHub](#), [Web Components](#)
- [Kyma GitHub](#), [Kyma blog post](#)
- [Spartacus GitHub](#)
- [Fundamental GitHub](#)
- [Luigi GitHub](#), [Luigi framework](#)
- [Code Pal for ABAP GitHub](#)
- [Project “Piper” GitHub](#), [webinar](#), [podcast](#)
- [Corona-Warn-App](#)

SAP Projects Open Sourced in 2022

- [risk-explorer-for-software-supply-chains](#)
- [open-ux-odata](#)
- [guided-answer-extension](#)
- [e-mobility-charging-stations-simulator](#)
- [wdio-qmate-service](#)
- [SAP Commerce DB Sync](#)
- [Curated Resources for Domain-Driven Design](#)

Examples of SAP Contributions to Open-Source Projects

- [Rust GitHub](#)
- [Metaflow-Argo Workflow GitHub](#)
- [Gerrit Code Review](#)
- [Eclipse JGit](#)
- [Cloud Robotics Project GitHub](#)
- [Vert.x GitHub](#)

2. Foundations

- [Eclipse Foundation](#), [Eclipse working groups](#)
- [Catena-X](#)
- [Industrial Digital Twin Association](#)
- [International Data Spaces Association](#)
- [Linux Foundation](#)
- [Linux Foundation Europe](#)
- [Cloud Native Computing Foundation](#)
- [Cloud Foundry Foundation](#), [podcast](#)
- [TODO Group](#)
- [SAP LinuxLab](#)
- [OASIS Open](#)
- [Bitkom](#)

3. Open-Source Consumption

- [OpenChain](#), [webinar](#), [podcast](#)
- [Fosstars GitHub](#)

4. Empowering Developers & Communities

- [SAP Open Source Community Page](#)
- [SAP Open Source Webinar Series](#)
- [The Open Source Way Podcast](#)
- [SAP Open Source Champions](#)
- [SAP GitHub](#)

5. InnerSource

- [InnerSource Commons Foundation](#)
- [InnerSource Portal](#), [InnerSource talk](#)

