



Zephyr Project:

Open Source Project Best Practices Over Time

Kate Stewart
Feb 1, 2025

Who am I?

Embedded Open Source:

- Zephyr Project: 2016 →
- Real Time Linux: 2016 → 2024
- ELISA Project: 2018 →
- Space Grade Linux: 2024 →

Volunteer:

- SPDX: 2009 →
- SBOM: 2018 →

Hobbies:

- Photography
- Travel to places with penguins

Contact:

kstewart@linuxfoundation.org

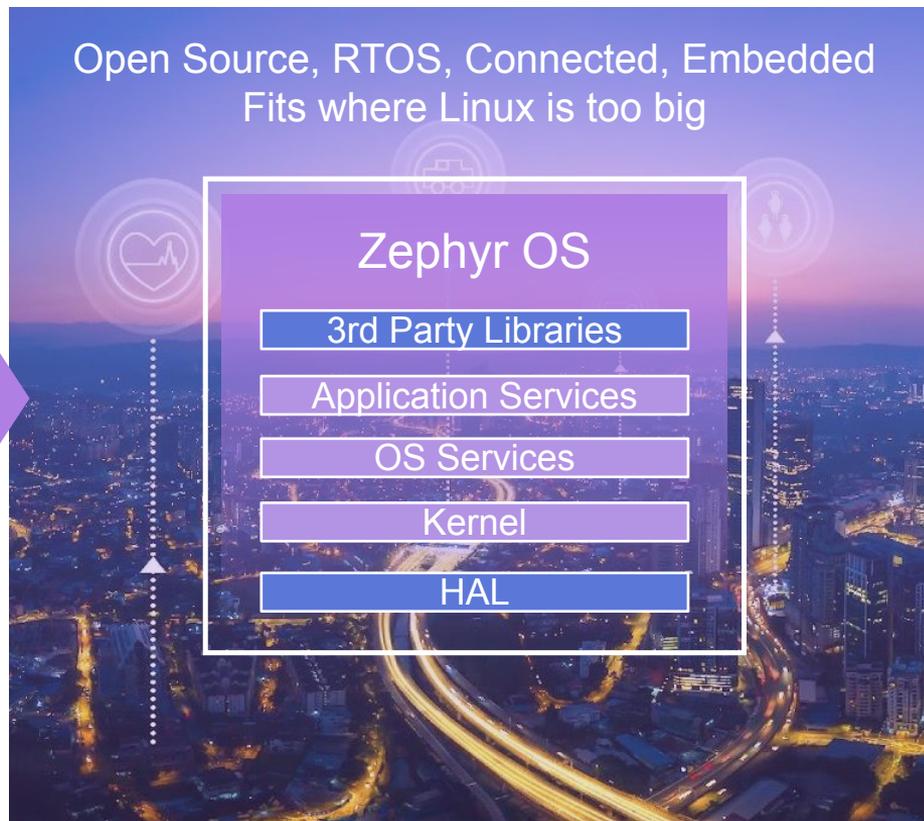
<https://www.linkedin.com/in/katestewartaustrin/>



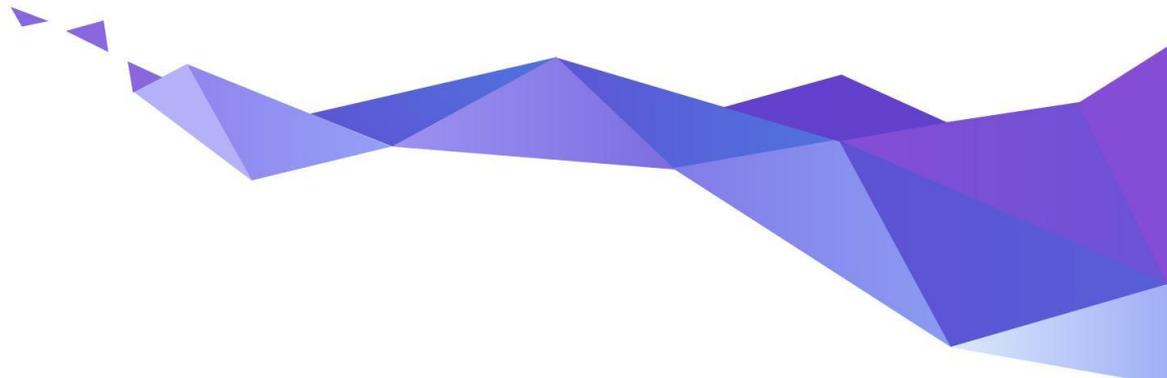
Zephyr Project



- **Open source** real time operating system
- **Developer friendly** with vibrant community participation
- Built with **safety and security** in mind
- **Broad SoC, board and sensor support.**
- **Vendor Neutral** governance
- **Permissively licensed** - Apache 2.0
- **Complete**, fully integrated, highly configurable, **modular** for **flexibility**
- **Product** development ready using LTS includes **security updates**
- **Certification** ready with Zephyr Auditable



Zephyr in 2024?





Zephyr[®]

2024 YEAR IN REVIEW

1,100



Unique Contributors

50%+

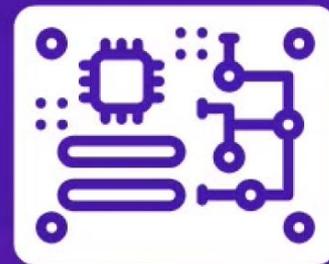
*First-Time
Contributors*

Source: <https://zephyrproject.org/zephyr-rtos-2024-wrap-up-a-year-of-growth-innovation-and-community-impact/>



2024 YEAR IN REVIEW

150



New Boards Added

Source: <https://zephyrproject.org/zephyr-rtos-2024-wrap-up-a-year-of-growth-innovation-and-community-impact/>

17 MEETUPS, 15 CITIES, 8 COUNTRIES

- 📍 Cologne, Germany
- 📍 Bangalore, India
- 📍 Berlin, Germany
- 📍 Erlangen, Germany
- 📍 Karlsruhe, Germany
- 📍 Maribor, Slovenia
- 📍 Paris, France
- 📍 Austin, Texas
- 📍 Israel
- 📍 Kanpur, India
- 📍 Munich, Germany
- 📍 Aarhus, Denmark
- 📍 Zurich, Switzerland
- 📍 Jena, Germany
- 📍 Hamburg, Germany



Zephyr®

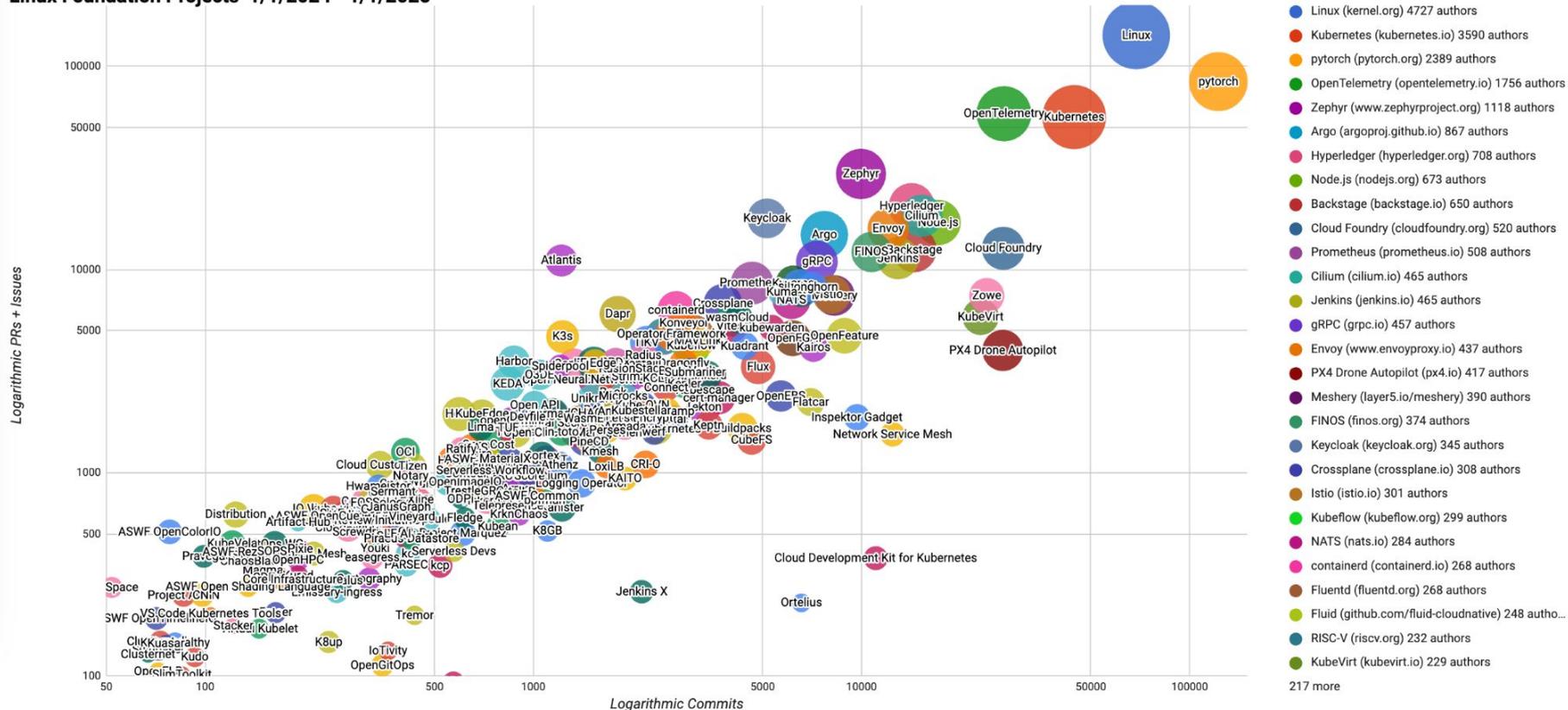
2024 YEAR IN REVIEW

Source: <https://zephyrproject.org/zephyr-rtos-2024-wrap-up-a-year-of-growth-innovation-and-community-impact/>

Linux Foundation Projects Velocity

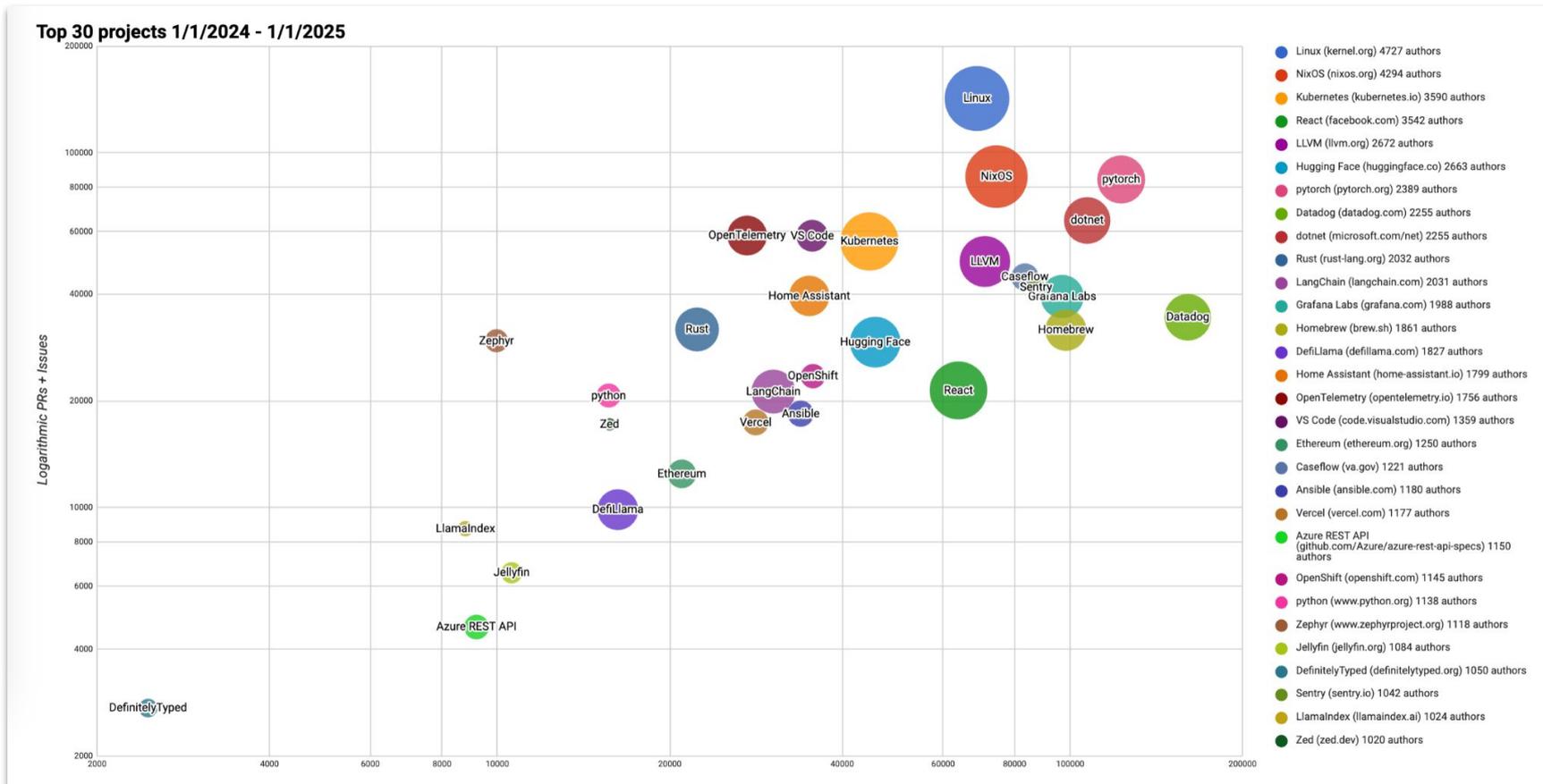


Linux Foundation Projects 1/1/2024 - 1/1/2025

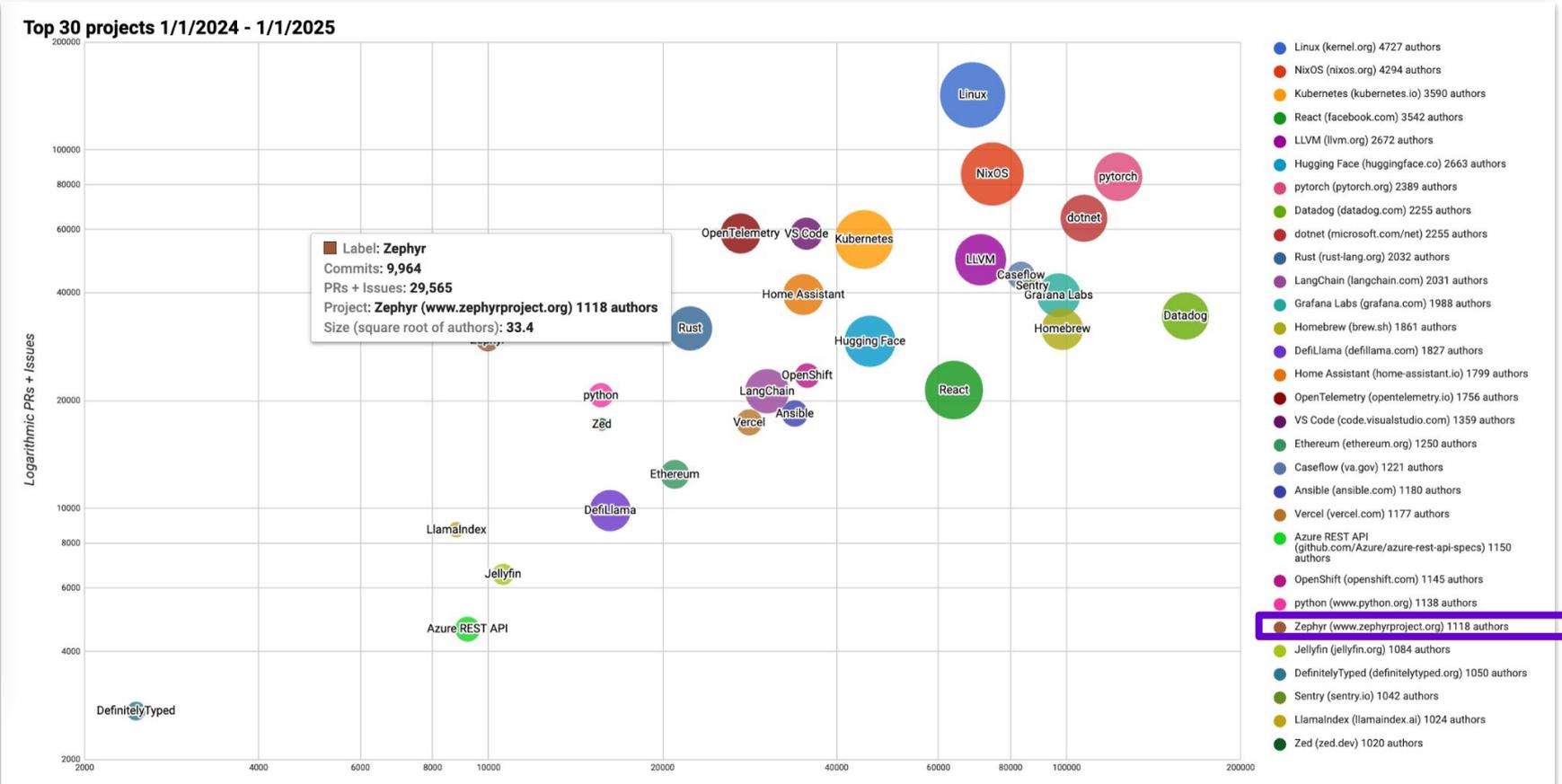


Source: <https://github.com/cncf/velocity>

Top Open Source Projects Velocity



Top Open Source Projects Velocity



Open Source RTOS Ecosystem

| Operating System | First Commit | Controls Commits | Declared License | Total Contributors | Contributors in last month | Total Commits | Commits in last month |
|------------------|--------------|------------------|----------------------------|--------------------|----------------------------|----------------|-----------------------|
| Zephyr | 2014/11 | community | Apache-2.0 | 2476 | 334 | 109,429 | 1,655 |
| nuttX | 2007/? | community | BSD-variant → Apache-2.0 | 593 | 62 | 57,664 | 357 |
| RT-Thread | 2009/06 | community | GPL-2.0 → Apache-2.0 | 729 | 28 | 16,855 | 78 |
| Tizen RT | 2015/04 | Samsung | BSD-variant → Apache-2.0 | 203 | 23 | 11,557 | 79 |
| RIOT | 2010/09 | community | LGPL-2.1 | 368 | 19 | 47,062 | 82 |
| FreeRTOS | 2004/07 | Richard Barry | GPL-2.0 w/ FreeRTOS → MIT | 207 | 9 | 3,565 | 14 |
| Contiki-NG | 2017/10 | community | BSD-3-Clause | 219 | 3 | 17,975 | 8 |
| SeL4 | 2014/07 | community | GPLv2 AND BSD-2-Clause | 113 | 2 | 4,615 | 3 |
| myNewt | 2015/06 | community | Apache-2.0 | 135 | 2 | 11,143 | 3 |
| mbed OS | 2013/02 | ARM | Apache-2.0 or BSD-3-Clause | 692 | 0 | 34,621 | 0 |
| ThreadX | 2020/05 | MSFT → community | MSL → MIT | 21 | 0 | 208 | 0 |

Data extracted on 2025-01-31 from github

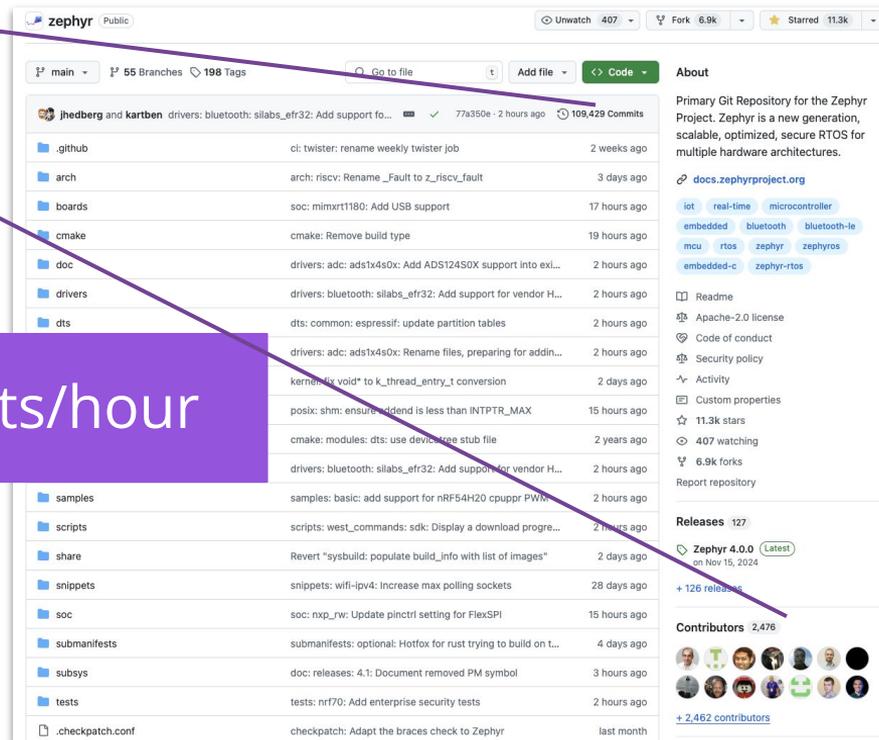
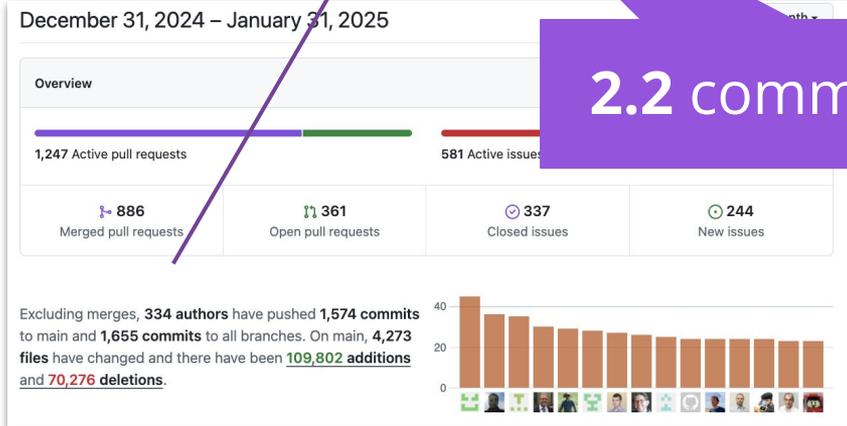
Methodology: Sample from Github

<https://github.com/zephyrproject-rtos/zephyr>

- Total commits: 109,429
- Total contributors: 2,476

<https://github.com/zephyrproject-rtos/zephyr/pulse/monthly>

- Monthly contributors: 334
- Monthly commits: 1,655



zephyr Public

Unwatch 407 Fork 6.9k Starred 11.3k

main 65 Branches 198 Tags

Go to file Add file Code

About

Primary Git Repository for the Zephyr Project. Zephyr is a new generation, scalable, optimized, secure RTOS for multiple hardware architectures.

docs.zephyrproject.org

iot real-time microcontroller embedded bluetooth bluetooth-le mcu rtos zephyr zephyros embedded-c zephyr-rtos

Readme

Apache-2.0 license

Code of conduct

Security policy

Activity

Custom properties

11.3k stars

407 watching

6.9k forks

Report repository

Releases 127

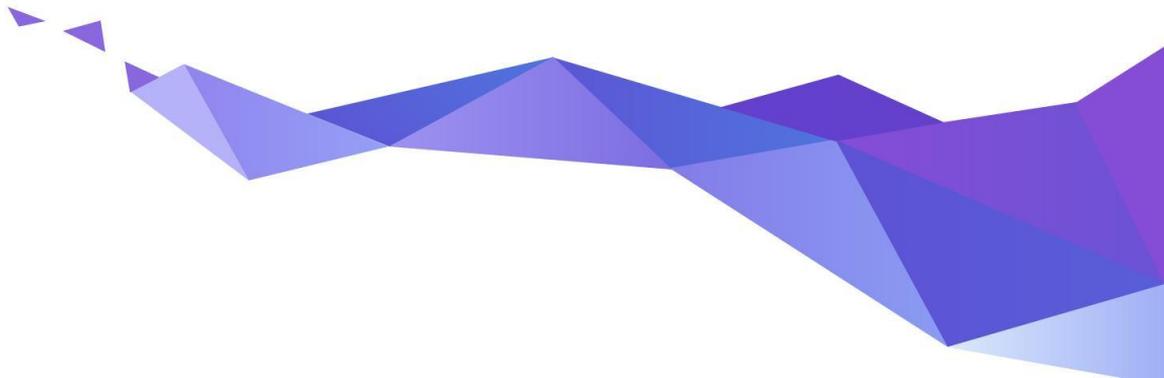
Zephyr 4.0.0 (Latest) on Nov 15, 2024

+ 126 releases

Contributors 2,476

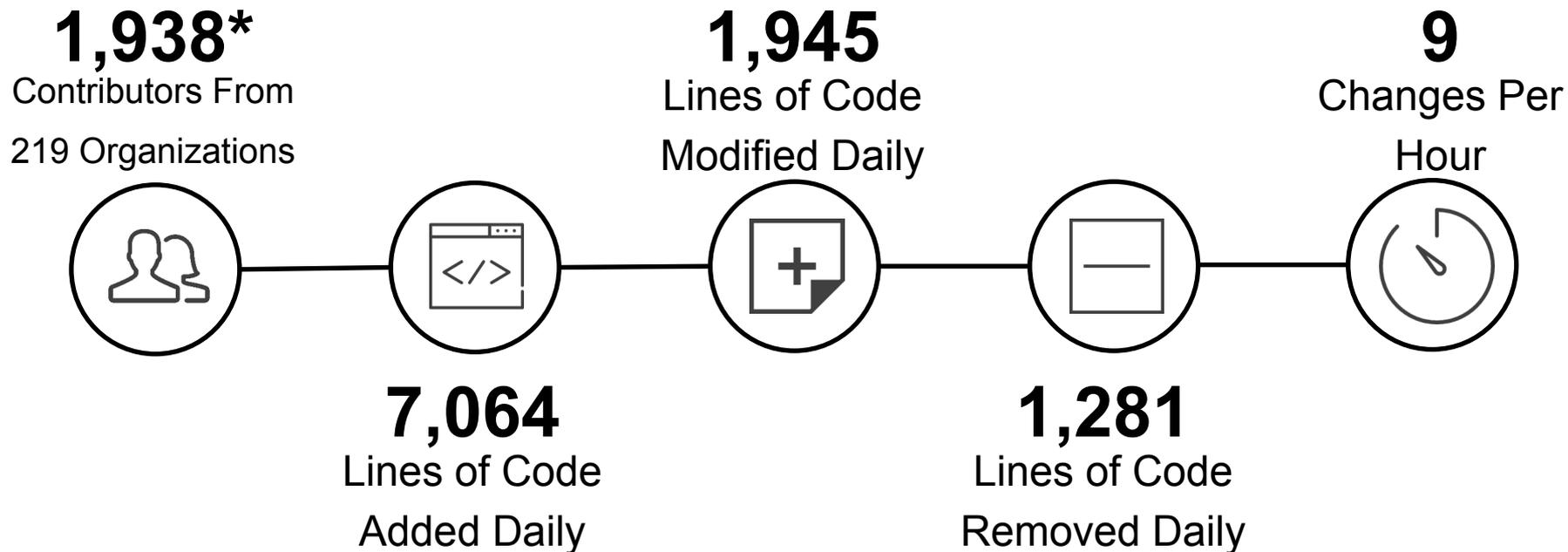
+ 2,462 contributors

How does this compare to the Linux Kernel?



How does this compare to Linux?

6.8 Linux Kernel Statistics*



* Source: <https://lwn.net/Articles/964106/> Time period for 6.8: 2024/1/8-2024/3/10=63 days
Also data from: Source: https://github.com/gregkh/kernel-history/blob/master/kernel_stats.ods from 6.5

So what was it like when Linux started?

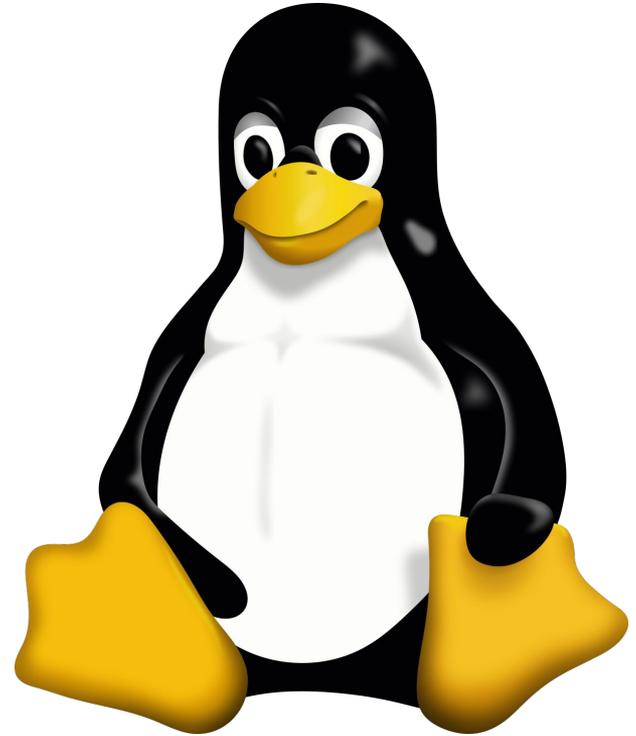
When Linux Started in 1991...

UNIX Source Available:

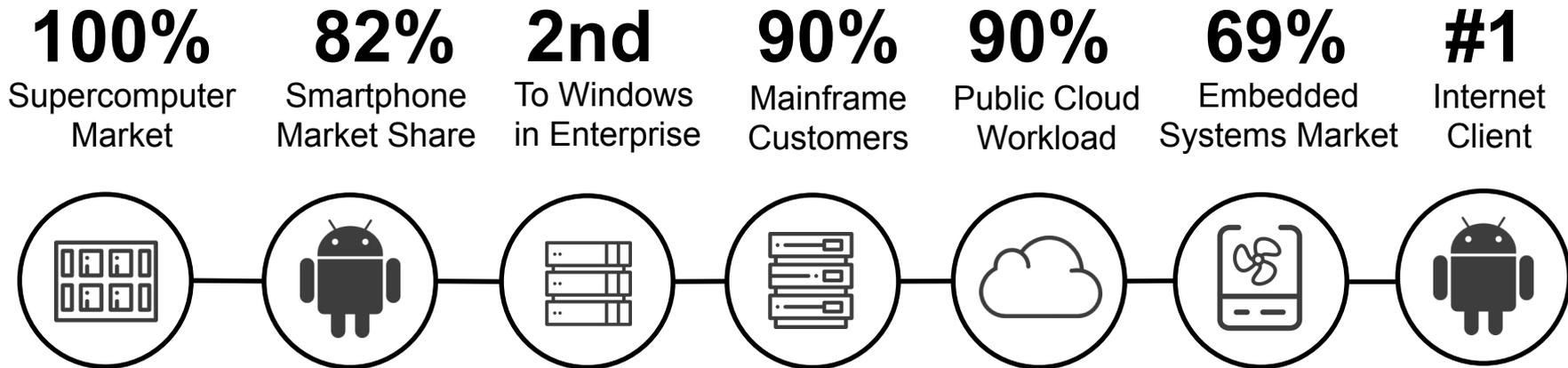
SVR4, MINIX 1.5, 4.3BSD

Commercial Distributions:

A/UX, IBM AIX, Dec Ultrix,
HP-UX, IRIX, SunOS, MIPS
RISC/os, Xenix ...



What is Linux like Today?



Every market Linux has entered it eventually dominated

Lessons Learned by Linux Community circa 2016/2017

Linux Kernel Development Report

Jonathan Corbet, *LWN.net*
Greg Kroah-Hartman, *The Linux Foundation*

Source:

<https://www.linuxfoundation.org/resource/publications/linux-kernel-report-2017>

More recent stats can be found at:

<https://www.linuxfoundation.org/tools/linux-kernel-history-report-2020/>

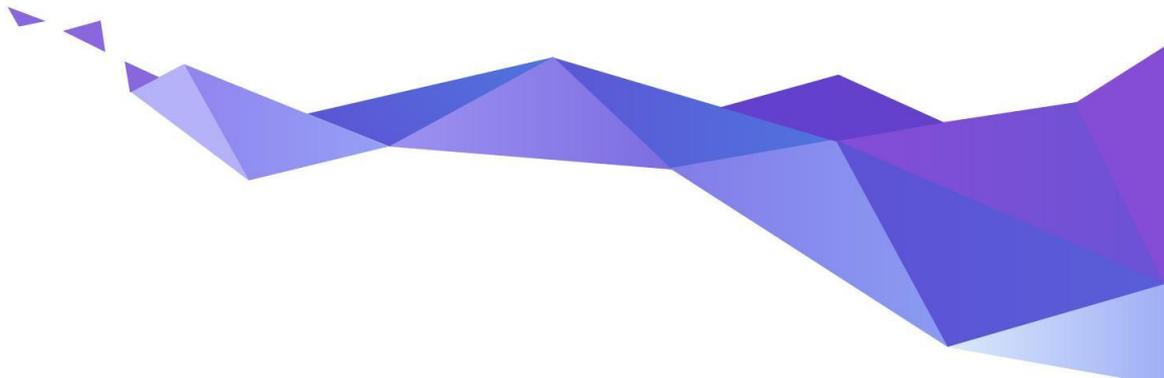
- Short release cycles are important.
- Process scalability requires a distributed, hierarchical development model.
- Tools matter.
- The kernel's strongly consensus-oriented model is important.
- A related factor is the kernel's strong "no regressions" rule.
- Corporate participation in the process is crucial.
- There should be no internal boundaries within the project

++ Lessons Learned

- **Vendor-neutral environment for technical decision making**
- Mix of companies and individuals participating – “scratching their itches”
- **Streamline upstreaming process** – DCO - “signed-off-by:”
- **Public code reviews** – “reviewed-by:”
- Consensus-oriented decision model – email, in-person summits
- Hierarchical development model (**maintainer model**) – “signed-off-by”
- No internal boundaries – developer can contribute anywhere
- **Tools matter** - git enabled distributed version control - push/pull
- Short predictable release cycles and **with fixed merge windows**
- **Stable & LTS:** stable and long term support releases support product development

KEY: Developer frustration with status quo inspires creative solutions.

So what lessons did Zephyr apply from the Linux Kernel Best Practices?



Zephyr's Vision

The Zephyr Project strives to deliver
the **best-in-class RTOS** for
connected resource-constrained
devices, built to be **secure and safe**.

Developers Decide Directions

- **Configuration:** kconfig & kbuild added in 2015 prior to launch
- **Unified kernel:** nano + microkernels → unified kernel in 2016
- **Infrastructure:** Gerrit/JIRA → GitHub/Issues in 2017
- **Build system:** kbuild → cmake in 2018
- **Code of Conduct:** adopted in 2018
- **Other areas:**
 - APIs & HALs - reworked
 - Modularization & Device Tree support
 - Release & LTS processes refined

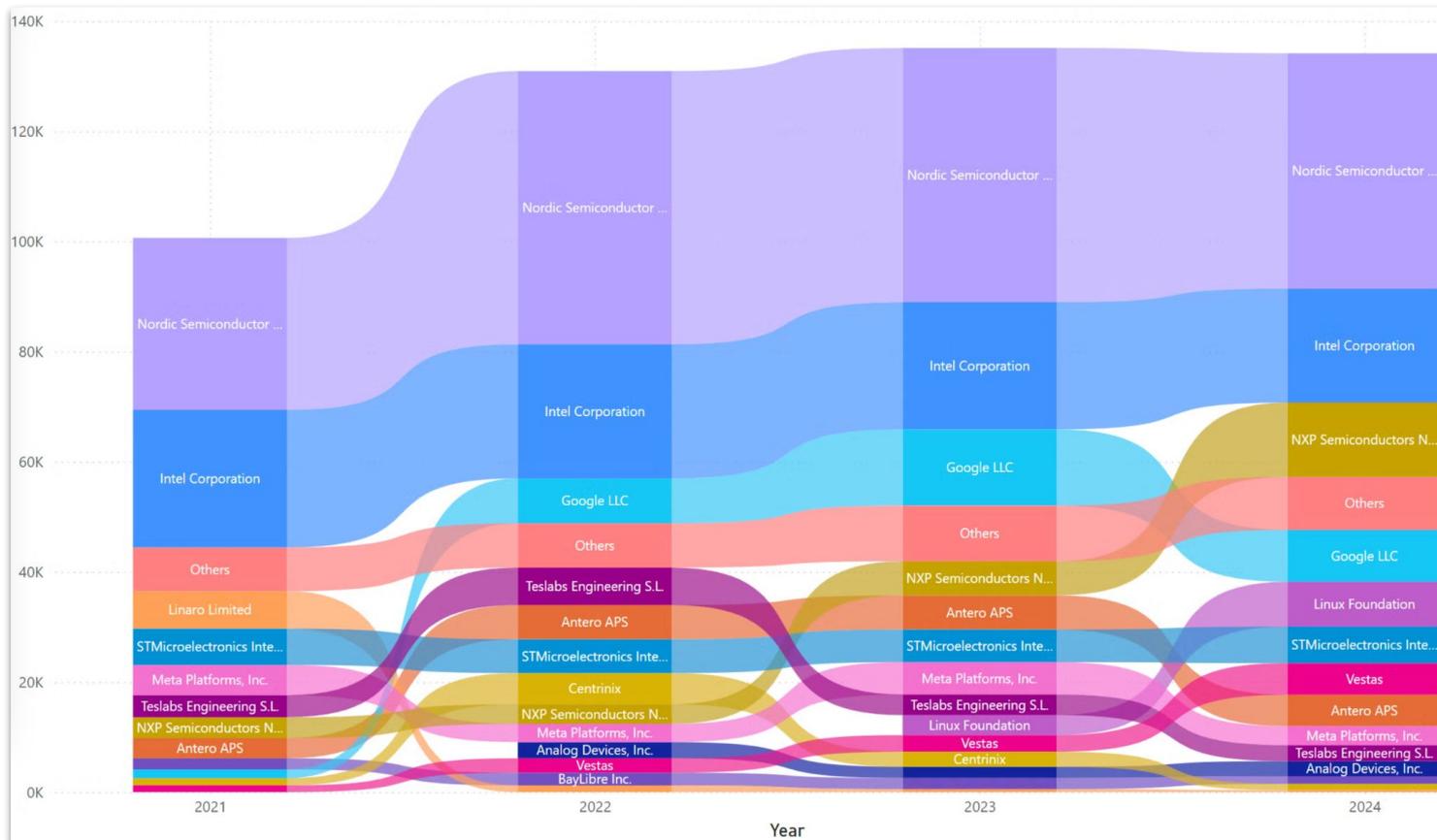
Applying ++ Lessons Learned

| Linux Best Practice | Zephyr Adoption |
|----------------------------------------|-----------------|
| Vendor Neutral Decision Making | |
| Companies and Individuals Participate | |
| Streamline upstreaming process | |
| Public code reviews? | |
| Consensus Oriented Decision Models | |
| Hierarchical development (Maintainers) | |
| No Internal Boundaries | |
| Distributed version control | |
| Short Release Cycle (w/ Merge Window) | |
| Long Term Support Releases | |

Applying ++ Lessons Learned



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Preview Code Blame 39 lines (28 loc) · 1.65 KB

Raw Copy Download Edit

Contribution Guidelines

As an open-source project, we welcome and encourage the community to submit patches directly to the project. In our collaborative open source environment, standards and methods for submitting changes help reduce the chaos that can result from an active development community.

This document briefly summarizes the full [Contribution Guidelines](#) documentation.

- Zephyr uses the permissive open source [`Apache 2.0 license`](#) that allows you to freely use, modify, distribute and sell your own products that include Apache 2.0 licensed software.
- There are some imported or reused components of the Zephyr project that use other licensing and are clearly identified.
- The Developer Certificate of Origin (DCO) process is followed to ensure developers are following licensing criteria for their contributions, and documented with a `Signed-off-by` line in commits.
- Zephyr development workflow is supported on Linux, macOS, and Windows, (with a few exceptions).
- Source code for the project is maintained in the GitHub repo: <https://github.com/zephyrproject-rtos/zephyr>
- Issue and feature tracking is done using GitHub issues in this repo.
- A Continuous Integration (CI) system runs on every Pull Request (PR) to verify several aspects of the PR including Git commit formatting, Coding Style, sanity checks builds, and documentation builds.
- The [Zephyr devel mailing list](#) is a great place to engage with the community, ask questions, discuss issues, and help each other.



Applying ++ Lessons Learned



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Release Life Cycle and Maintenance

Periodic Releases

The Zephyr project provides periodic releases every 4 months leading to the long term support releases approximately every 2 years. Periodic and non-LTS releases are maintained with updates, bug fixes and security related updates for at least two cycles, meaning that the project supports the most recent two releases in addition to the most recent LTS.

Long Term Support and Maintenance

A Zephyr [Long Term Support \(LTS\)](#) release is published every 2 years and is branched and maintained independently from the main tree for at least 2.5 years after it was released.

Support and maintenance for an LTS release stops at least half a year after the following LTS release is published.

Applying ++ Lessons Learned



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| Short Release Cycle (w/ Merge Window) | Yes, 10 week merge, 2-4 week stabilize |
| Long Term Support Releases | |

Supported Releases

| Release | Release date | EOL |
|------------------------------|--------------|------------|
| Zephyr 2.7.6 | 2024-03-01 | 2025-01-26 |
| Zephyr 3.7.0 | 2024-07-26 | 2027-01-26 |
| Zephyr 4.0.0 | 2024-11-15 | 2025-07-18 |

As of 2022-01-01, LTS1 (1.14.x) is not supported and has reached end of life (EOL).

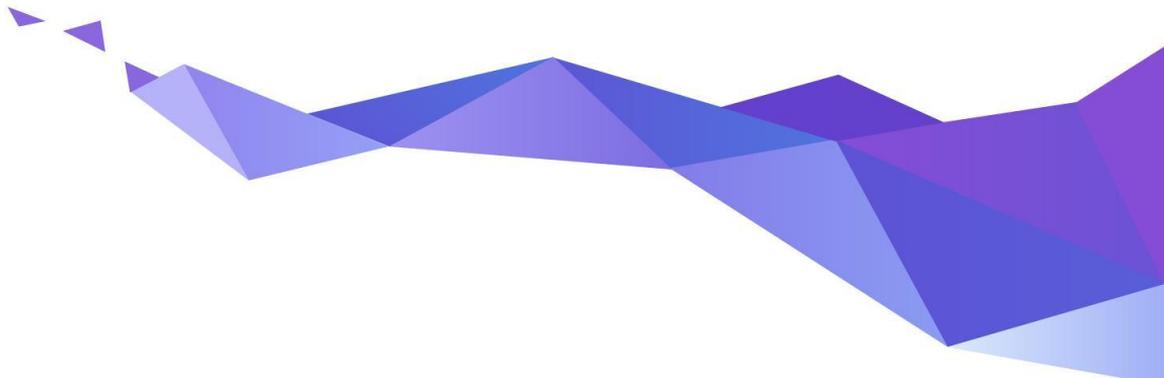
Source: <https://docs.zephyrproject.org/latest/releases/index.html#supported-releases>

Applying ++ Lessons Learned

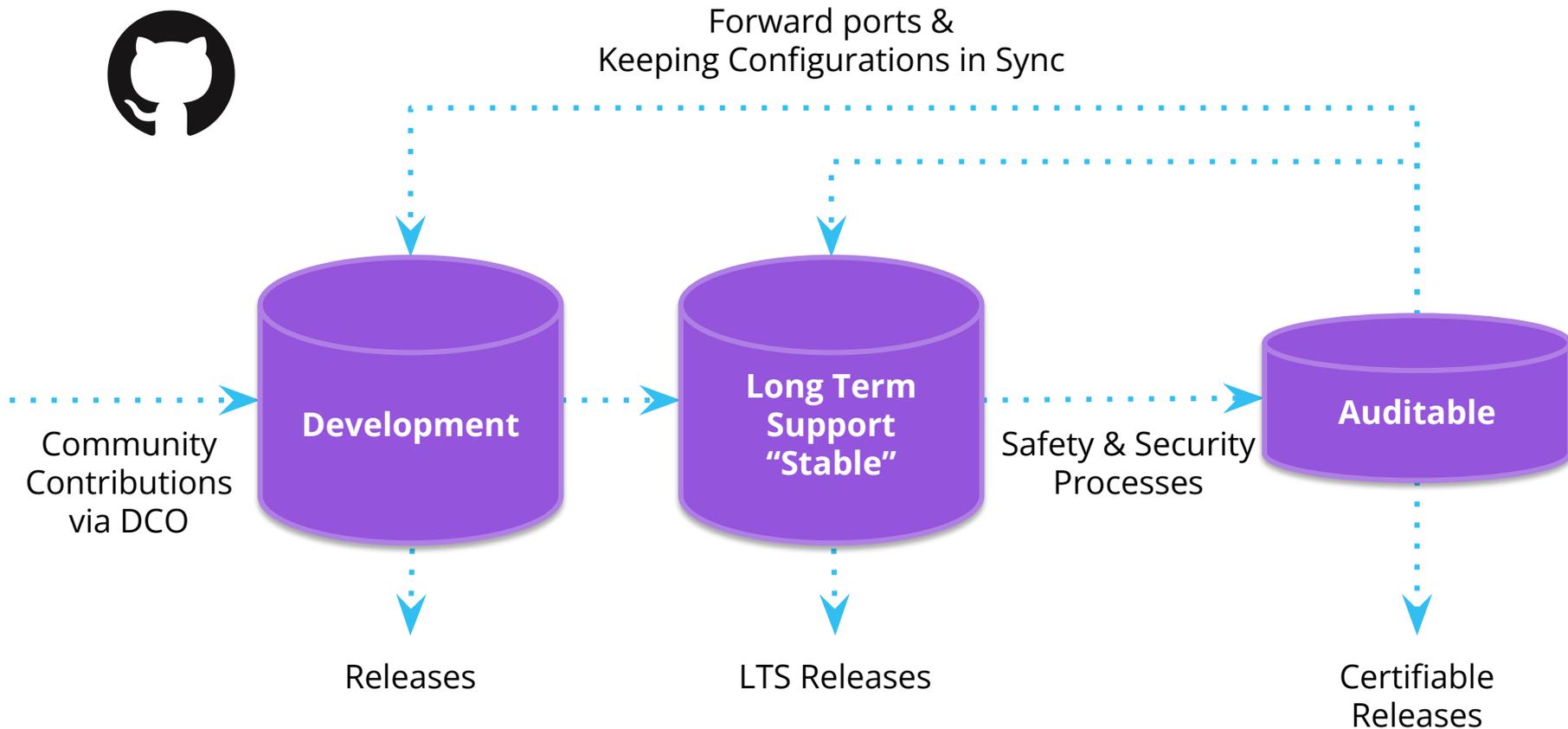


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| Long Term Support Releases | Yes, LTS 2 had 6 update release, LTS 3 active maintain |

What about Zephyr security best practices?



Code Repositories



Zephyr 4.0 (November 2024)



Zephyr 4.0.0

We are pleased to announce the release of Zephyr version 4.0.0.

Major enhancements with this release include:

- **Secure Storage Subsystem:** A newly introduced [secure storage](#) subsystem allows the use of the PSA Secure Storage API and of persistent keys in the PSA Crypto API on *all* board targets. It is now the standard way to provide device-specific protection to data at rest. ([GitHub #76222](#))
- **ZMS (Zephyr Memory Storage) Subsystem:** ZMS is a new key-value storage subsystem compatible with all non-volatile storage types, including traditional NOR flash and advanced technologies like RRAM and MRAM that support write without erasure.
- **Analog Comparators:** A new [comparator](#) device driver subsystem for analog comparators has been added, complete with shell support. It supports initial configuration through Devicetree and runtime configuration through vendor specific APIs. Initially the [nordic,nrf-comp](#), [nordic,nrf-lpcomp](#) and [nxp,kinetis-acmp](#) are supported.
- **Stepper Motors:** It is now possible to interact with stepper motors using a standard API thanks to the new [stepper](#) device driver subsystem, which also comes with shell support. Initially implemented drivers include a simple [zephyr,gpio-steppers](#) and a complex sensor-less stall-detection capable with integrated ramp-controller [adi,tmc5041](#).
- **Haptics:** A new [Haptics](#) device driver subsystem allows unified access to haptic controllers, enabling users to add haptic feedback to their applications.
- **Multimedia Capabilities** Zephyr's audio and video capabilities have been expanded with support for new image sensors, video interfaces, audio interfaces, and codecs being supported.
- **Prometheus Library:** A [Prometheus](#) metrics library has been added to the networking stack. It provides a way to expose metrics to Prometheus clients over HTTP, facilitating the consolidated remote monitoring of Zephyr devices alongside other systems typically monitored using Prometheus.
- **Documentation Improvements:** Several enhancements were made to the online documentation to improve content discovery and navigation. These include a new [interactive board catalog](#) and an interactive directory for [code samples](#).
- **Expanded Board Support:** Over 60 [new boards](#) and [shields](#) are supported in Zephyr 4.0.

An overview of the changes required or recommended when migrating your application from Zephyr v3.7.0 to Zephyr v4.0.0 can be found in the separate [migration guide](#).

To Learn More:

[Zephyr 4.0](#) &

[Release notes 4.0](#)

→ **Next release: Zephyr 4.1**

Zephyr 3.7 LTS (July 2024)



 **New Hardware Model**

 Integration of **TF-M PSA Crypto API**

 Support for **Precision Time Protocol (PTP)**

 **SBOM generation** supports **SPDX 2.3 & PURL/CPE**

To Learn More: [3.7 Blog Post](#) & [Release notes 3.7](#)

LTS Support Windows



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|------------------------------|--------------|------------|
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| Zephyr 3.7.0 | 2024-07-26 | 2027-01-26 |
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Source: <https://docs.zephyrproject.org/latest/releases/index.html#supported-releases>

Long Term Support (Zephyr 3.7.x)



- **Product Focused**
- Current with latest **Security Updates**
- Compatible with new hardware
 - Functional support for new hardware is regularly backported
- **Tested:** Shorten the development window and extend the Beta cycle to allow for more testing and bug fixing
- **Supported for 2+ years**
- **⚠ Doesn't include cutting-edge functionality**



<https://docs.zephyrproject.org/3.7.0/>

Long Term Support

A collage of four overlapping screenshots from the Zephyr project's GitHub repository, showing release announcements for versions 1.14.0, 1.14.1, 1.14.2 (Maintenance Release), and v1.14.3. Each screenshot highlights the "Security Vulnerability Related" and "Issues Fixed" sections, demonstrating the project's commitment to addressing vulnerabilities and bugs over time.

Zephyr 1.14.0
Major enhancements with this release include:

- The Zephyr project now supports over 160 different board configurations spanning 8 architectures. All architectures are rigorously tested and validated using one of the many simulation platforms supported by the project: QEMU, Renode, ARC Simulator, and the native POSIX configuration.
- The timing subsystem has been reworked and reimplemented, greatly simplifying the resulting drivers, removing thousands of lines of code, and reducing a typical kernel default size by hundreds of bytes. TICKLESS_KERNEL mode is now the default on all architectures.
- The Symmetric Multi-Processing (SMP) subsystem continues to evolve with the addition of a new CPU affinity API that can "pin" threads to specific cores or sets of cores. The core kernel no longer uses the global irq lock on SMP systems, and exclusively uses the spinlock API (which on uniprocessor systems reduces to the same code).
- Zephyr now has support for the m68k architecture. It is currently implemented only for QEMU targets, supports arbitrary numbers of CPUs, and runs in SMP mode by default, our first platform to do so.
- We've overhauled the Network packet net_pkt API and moved the majority of components and protocols to use the BSD socket API, including MQTT, CoAP, LWMEM, and SNTP.

Zephyr 1.14.1
This is an LTS maintenance release with fixes, as well as Bluetooth qualification listings for the Bluetooth protocol stack included in Zephyr.

Security Vulnerability Related
The following security vulnerability (CVE) was addressed in this release:

- Fixes CVE-2019-9506: The Bluetooth BR/EDR specification up to and including version 5.1 permits sufficiently low encryption key length and does not prevent an attacker from influencing the key length negotiation. This allows practical brute-force attacks (aka "KNOCK") that can decrypt traffic and inject arbitrary ciphertext without the victim noticing.

Bluetooth

- Qualification:
 - 1.14.x Host subsystem qualified with QCID 139258
 - 1.14.x Mesh subsystem qualified with QCID 139259
 - 1.14.x Controller component qualified on Nordic nRF52 with QCID 135679

Issues Fixed
These GitHub issues were addressed since the previous 1.14.0 tagged release:

Zephyr LTS 1.14.2 (Maintenance Release)
This is an LTS maintenance release with fixes.

Security Vulnerability Related
The following security vulnerabilities (CVEs) were addressed in this release:

- CVE-2020-10019
- CVE-2020-10021
- CVE-2020-10022
- CVE-2020-10023
- CVE-2020-10024
- CVE-2020-10027
- CVE-2020-10028

More detailed information can be found in: <https://docs.zephyrproject.org/latest/security/vulnerabilities.html>

Issues Fixed
These GitHub issues were addressed since the previous 1.14.0 tagged release:

Zephyr v1.14.3
This is an LTS maintenance release with fixes.

Security Vulnerability Related
The following security vulnerabilities (CVEs) were addressed in this release:

- CVE-2020-10066
- CVE-2020-10069
- CVE-2020-13601
- CVE-2020-13602

More detailed information can be found in: <https://docs.zephyrproject.org/latest/security/vulnerabilities.html>

Issues Fixed
These GitHub issues were addressed since the previous 1.14.0 tagged release:

- #18334 - DNS resolution is broken for some addresses in master/2.0-pre
- #19917 - Bluetooth: Controller: Missing LL_ENC_RSP after HCI LTK Negative Reply
- #21107 - LL_ASSERT and "imprecise data bus error" in LL Controller
- #21257 - tests/helptel_pkt failed on mimmi1050_evk board.
- #21259 - bluetooth: Controller does not release buffer on central side after peripheral reset

Delivered bug fixes and latest security updates for 2 years!

Security Focus From the Start



Exhibit B

Zephyr Project Charter (the “Charter”)

The Linux Foundation
Updated August 21, 2023

1. Mission of the Zephyr Project (“Zephyr,” or, alternatively, the “Project”).

The mission of the Project is to:

- a. deliver the best-in-class RTOS for connected resource-constrained devices, built to be secure and safe.
- b. maintain an auditable code base, while taking advantage of community participation; this auditable code base is open source;
- c. include participation of leading members of this ecosystem, including micro-controller manufacturers, hardware developers, software developers and other members of the ecosystem; and
- d. host the infrastructure for the open source Project and sub-projects, establishing a neutral home for community meetings, events and collaborative discussions and providing structure around the business and technical governance of the Project.

Security Focus From the Start



Exhibit B

Zephyr Project Charter (the “Charter”)

The Linux Foundation

1. Mission of the Zephyr

The mission of the Project is

- a. deliver the best-in-class embedded Linux operating system to be secure and
- b. maintain an audit-ready code base with high developer participation; the
- c. include participation from all Zephyr controller manufacturers and members of the ecosystem
- d. host the infrastructure for the Project as a neutral home for providing structure

6. Security Committee

- a. Composition – the Security Committee members shall consist of:
 - i. one appointed voting representative from each Platinum Member, plus
 - ii. non-voting Silver Member representatives who shall not count towards quorum.
- b. Responsibilities – the Security Committee shall be responsible for:
 - i. the definition of the processes to ensure an auditable code base, as well as any associated certification artifacts (“Security Artifacts”);
 - ii. annually elect a Representative on the Security Committee to serve as chair of the Security Committee; and
 - iii. annually elect a security architect (the “Security Architect”), who may be different from the chair of the Security Committee.

Starting Point: Adopt Known Best Practices



The screenshot shows a web browser window displaying the homepage of the CII Best Practices Badge Program. The browser's address bar shows the URL <https://bestpractices.coreinfrastructure.org/en>. The website has a dark navigation bar with the CII logo and the text "CII Best Practices". On the right side of the navigation bar are links for "Projects", "Sign Up", and "Login". The main content area features a large heading "CII Best Practices Badge Program" and a green button that says "Get Your Badge Now!". Below the heading is a paragraph explaining the program: "The Linux Foundation (LF) Core Infrastructure Initiative (CII) Best Practices badge is a way for Free/Libre and Open Source Software (FLOSS) projects to show that they follow best practices. Projects can voluntarily self-certify, at no cost, by using this web application to explain how they follow each best practice. The CII Best Practices Badge is inspired by the many badges available to projects on GitHub. Consumers of the badge can quickly assess which FLOSS projects are following best practices and as a result are more likely to produce higher-quality secure software." A second paragraph provides more information: "More information on the CII Best Practices Badging program, including background and criteria, is available on GitHub. Project statistics and criteria statistics are available. The projects page shows participating projects and supports queries (e.g., you can see projects that have a passing badge). You can also see an example (where we try to get our own badge)." At the bottom left, there is a note: "Privacy and legal issues: Please see our privacy policy, about cookies, and terms of use. The code for the". On the right side of the page, there is a circular logo for the "CORE INFRASTRUCTURE INITIATIVE BEST PRACTICES" featuring a yellow trophy. Below the logo, the text "Some badge earners:" is followed by a grid of logos for various projects including Kubernetes, Hyperledger, Node.js, LibreOffice, curl, GitLab, Prometheus, pkgsrc, Xen Project, openstack, NVM, Zephyr, and gyncope.

<https://bestpractices.coreinfrastructure.org>

Best Practices Badge



Identified best practices for OSS projects

- For *production* of OSS
- Based on practices of well-run OSS projects
- Increase likelihood of better quality & security
- Criteria designed for *any* OSS project

Web application: OSS projects self-certify

- If OSS project meets criteria, it gets a badge
- No cost
- Self-certification mitigated by automation, public display of answers (for criticism), spot-checks, and can be overridden if false

⇒ moved under Open SSF in 2021



OpenSSF Best Practices Badge Program

Get Your Badge Now!

The [Open Source Security Foundation \(OpenSSF\)](#) Best Practices badge is a way for Free/Libre and Open Source Software (FLOSS) projects to show that they follow best practices. Projects can voluntarily self-certify, at no cost, by using this web application to explain how they follow each best practice. The OpenSSF Best Practices Badge is inspired by the many badges available to projects on GitHub. Consumers of the badge can quickly assess which FLOSS projects are following best practices and as a result are more likely to produce higher-quality secure software.

You can easily see the [criteria for the passing badge](#). More information on the OpenSSF Best Practices Badging program is [available on GitHub](#). [Project statistics](#) and [criteria statistics](#) are available. The [projects page](#) shows participating projects and supports queries (e.g., you can see [projects that have a passing badge](#)). You can also see [an example \(where we try to earn our own badge\)](#). This project was formerly known as the Core Infrastructure Initiative (CII) Best Practices badge, and was originally developed under the CII. It is now part of the [OpenSSF Best Practices Working Group \(WG\)](#). The OpenSSF is a foundation of the [Linux Foundation \(LF\)](#). The project was formally renamed from "CII Best Practices badge" on 2021-12-24.



Some badge earners:



Source: <https://www.bestpractices.dev>

Criteria



Three badge levels (passing, silver, gold)

- Any level is an achievement
- For higher levels, must meet previous level
- Based on real projects
 - Not “people should do X, but no one does that”
- Gold requires multiple developers
 - bus factor > 1*, 2-person review



More info at: <https://github.com/coreinfrastructure/best-practices-badge>

* A “bus factor” is how many people would have to be hit by a bus before a project stalls (e.g., due to lack) knowledge)

Statistics about Criteria & Levels



Criteria Statistics

| Level | Total active | MUST | SHOULD | SUGGESTED | Allow N/A | Met justification required | Require URL | Met justification or URL required | Includes details | New at this level | Future |
|---------|--------------|------|--------|-----------|-----------|----------------------------|-------------|-----------------------------------|------------------|-------------------|--------|
| Passing | 67 | 43 | 10 | 14 | 27 | 1 | 8 | 9 | 52 | 67 | 0 |
| Silver | 55 | 44 | 10 | 1 | 41 | 38 | 17 | 54 | 39 | 48 | 0 |
| Gold | 23 | 21 | 2 | 0 | 9 | 13 | 9 | 22 | 16 | 14 | 0 |

The "active" criteria are criteria that are included in the percentage calculations (as opposed to "future" criteria). The next columns identify the number of active criteria in each level that are MUST, SHOULD, SUGGESTED, allow a "N/A" as an answer, require justification when "met" is the answer, require a URL, require justification when "met" is the answer or a URL, include details, or are new at this level. "Future" criteria are shown on the form, and are expected to be added as active criteria to some level in the future, but are not included in completion calculations.

You can see statistics about projects over time at the [project stats page](#).

You may also see the [actual criteria](#).

- There are not a lot of gold criteria, but they are challenging.
- Source: <https://www.bestpractices.dev/en/criteria>

Zephyr's Path - Initial Passing Badge



Zephyr Launched 2016/2

- Initial security team was composed of device security experts or either open source embedded experts from our members, but limited knowledge domain overlap and understanding of issues in either space.

CII badge program launched 2016/5

- Looked through the criteria and decided to aim for passing badge.
- 75% was straight forward to fill out and was done within first week.
- Security and Analysis sections served as a focus to start organizing knowledge from diverse participants in the security team.



Zephyr achieved "Passing" badge 2016/11

- Some criteria we met fairly easily, other criteria caused significant discussion, and took a while to create the documentation (which we needed to do!)

cii best practices **passing**

Project Security Documentation



- [Project Security Overview](#)
- Started with documents from other projects
- Built around Secure Development, Secure Design, and Security Certification
- Ongoing process, rather than something to just be accomplished



[Docs / Latest](#) » [Security](#) » [Zephyr Security Overview](#)  [Open on GitHub](#)  [Report an issue with this page](#)

This is the documentation for the latest (main) development branch of Zephyr. If you are looking for the documentation of previous releases, use the drop-down menu on the left and select the desired version.

Zephyr Security Overview

Introduction

This document outlines the steps of the Zephyr Security Subcommittee towards a defined security process that helps developers build more secure software while addressing security compliance requirements. It presents the key ideas of the security process and outlines which documents need to be created. After the process is implemented and all supporting documents are created, this document is a top-level overview and entry point.

Overview and Scope

We begin with an overview of the Zephyr development process, which mainly focuses on security functionality.

In subsequent sections, the individual parts of the process are treated in detail. As depicted in Figure 1, these main steps are:

1. **Secure Development:** Defines the system architecture and development process that ensures adherence to relevant coding principles and quality assurance procedures.
2. **Secure Design:** Defines security procedures and implement measures to enforce them. A security architecture of the system and relevant sub-modules is created, threats are identified, and countermeasures designed. Their

Zephyr's Path - Oops... Passing Regained

Zephyr stopped “Passing” 2017/2

- Zephyr project infrastructure underwent significant transition in 2017 (JIRA → Issues, Gerrit → github)
- Prior data was inaccurate, and we had forgotten to update it.
- Badge app notified us we were not longer “passing”

cii best practices **in progress 85%**

Zephyr regains passing 2017/8

- After all transitions done, updated documentation to reflect the infrastructure and we were passing again.
- **Decided to try for Silver** – but there were some big lifts for the project: key roles and responsibilities documented, longer roadmap than we’d been keeping, TLS certificate verification

cii best practices **passing**

Zephyr's Path - Become a CNA?



A CNA allows Zephyr Project to manage vulnerabilities, assign them CVE IDs, and handle the disclosure of information pertaining to those vulnerabilities.

- Zephyr Project CNA determines the validity of issues/vulnerabilities,
- whether or not they will be publicly disclosed,
- the amount of information that will be disclosed,
- the timing for that disclosure.

Changes made by the Zephyr Project to become a CNA:

- Zephyr Project security **documentation was reviewed and modified** to handle the new requirements levied by the CNA process.
- **New email lists** were created to be used as points of contact for external entities (provided to MITRE to be used for contact and also will be added to Zephyr Project websites).
 - vulnerabilities@zephyrproject.org (used as primary contact for external entities)
 - zephyr-psirt-request@lists.zephyrproject.org (internal project list for CNA communications)

Zephyr's Path - Become a CNA? Yes!



Four things required* for getting a CNA in place:

1. Definition of scope:
All Zephyr project components and vulnerabilities discovered by Zephyr project participants that are not covered by another CNA.
2. Public point of contact:
vulnerabilities@zephyrproject.org was listed on websites (both Zephyr project and MITRE).
3. Direct point of contact for backdoor communications from MITRE:
zephyr-psirt-request@lists.zephyrproject.org
4. A list of email addresses that will be added to the MITRE announcement:
zephyr-psirt-request@lists.zephyrproject.org

Sent email with above in August 2017, and MITRE announced Zephyr as CNA

*per phone discussion with MITRE, July 2017

Zephyr Listed as CNA in NVD in 2017



| Product, Vendor, or Product Category Name | Scope | CNA Contact Email and/or Webpage (if applicable) | CNA Type* |
|-------------------------------------------|---------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------|
| MITRE Corporation | All vulnerabilities not already covered by a CNA listed on this page | MITRE CVE Request web form | Primary CNA |
| Zephyr Project | Zephyr project components and vulnerabilities that are not covered by another CNA | vulnerabilities@zephyrproject.org | Vendors and Projects |
| Zero Day Initiative | Products and projects covered by its bug bounty programs not already covered by another CNA | zdi-disclosures@trendmicro.com ZDI contact page | Bug Bounty Programs |
| ZTE Corporation | ZTE products only | psirt@zte.com.cn | Vendors and Projects |

* Key for CNA Types:

Bug Bounty Programs - assigns CVE IDs to products and projects that utilize the Bug Bounty service's product offerings.

National and Industry CERTs - performs incident response and vulnerability disclosure services for nations or industries. They may assign CVE IDs as part of their role and scope.

Primary CNA - oversees the CNA program.

Root CNA - manages a group of sub-CNAs within a given domain or community.

Vendors and Projects - assigns CVE IDs for vulnerabilities found in their own products and projects.

Vulnerability Researchers - assigns CVE IDs to products and projects upon which they perform vulnerability analysis.

* https://cve.mitre.org/cve/request_id.html#cna_participants

Zephyr CNA Entry Today



CVE About Partner Information Program Organization Downloads Resources & Support Report

Zephyr Project

Links that redirect to external websites [↗](#) will open a new window or tab depending on the web browser used.

Steps to Report a Vulnerability or Request a CVE ID

| | |
|---------------------------------------------------------------|------------------------------------------|
| Step 1: Read disclosure policy View Policy | Step 2: Contact Email |
|---------------------------------------------------------------|------------------------------------------|

| | |
|----------------------------|------------------------------------------------------------------------------------|
| Scope | Zephyr project components, and vulnerabilities that are not in another CNA's scope |
| Program Role | CNA |
| Top-Level Root | MITRE Corporation |
| Security Advisories | View Advisories |
| Organization Type | Vendor Open Source |
| Country* | USA |

* Self-identified by CNA

Source: <https://www.cve.org/PartnerInformation/ListofPartners/partner/zephyr>

Zephyr PSIRT Today



Project Security Incident Response Team

- Led by Zephyr Security Architect (elected annually from peers)
- Volunteers from Security Committee (Zephyr Project Members) do initial triage
- Manage embargo windows and interaction with maintainers for fixes into upstream and then backports to LTS
- Responsible for satisfying evolving CVE Program & CNA Process Requirements.

Zephyr's Badge Path Continues...



Zephyr almost at "Silver" 2018/4

- Zephyr addressed all issues except "TLS certificate verification", we had a TLS library, but Zephyr is an OS, not an App.
- Threat model and justification documents that security requirements are met had to be created, again issue not an App.

cii best practices **passing**

Zephyr gets Silver 2018/9

- After implementing a separate application as a sample for TLS issue

cii best practices **silver**

Zephyr's Gold Badge - Feb 2019!



Zephyr Project

Projects that follow the best practices below can voluntarily self-certify and show that they've achieved an Open Source Security Foundation (OpenSSF) best practices badge. [Show details](#)

If this is your project, please show your badge status on your project page! The badge status looks like this: `openssf best practices gold` Here is how to embed it: [Show details](#)

These are the `passing` level criteria. You can also view the `silver` or `gold` level criteria.

[Expand panels](#)

[Show all details](#)

[Show only incomplete criteria](#)

| | |
|----------------|-------|
| Basics | 13/13 |
| Change Control | 9/9 |
| Reporting | 8/8 |
| Quality | 13/13 |
| Security | 16/16 |
| Analysis | 8/8 |

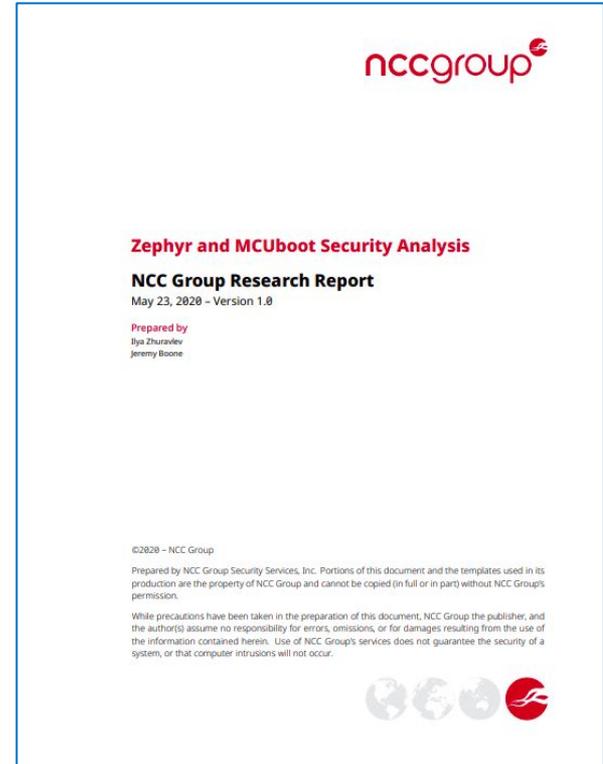
This data is available under the [Creative Commons Attribution version 3.0 or later license \(CC-BY-3.0+\)](#). All are free to share and adapt the data, but must give appropriate credit.

Source: <https://www.bestpractices.dev/en/projects/74>

First Bulk Security Report (2019)



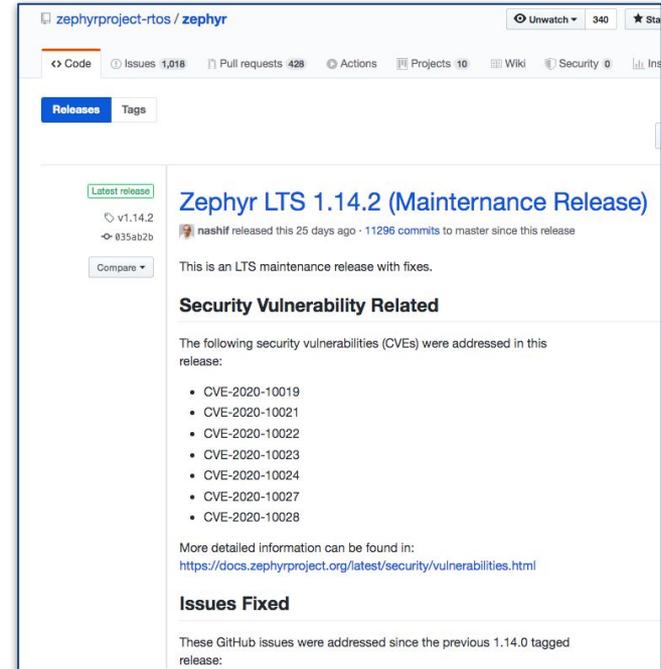
- [NCC Group reported](#) ~26 issues
- Critical, High and Medium made into JIRA tickets (we used JIRA before transitioning private github we use today)
- All were addressed
- After embargo, everything updated in the [vulnerability report](#) page
- Most resulted in 1 or more CVEs being reported



Results from the 2019 NCC Report



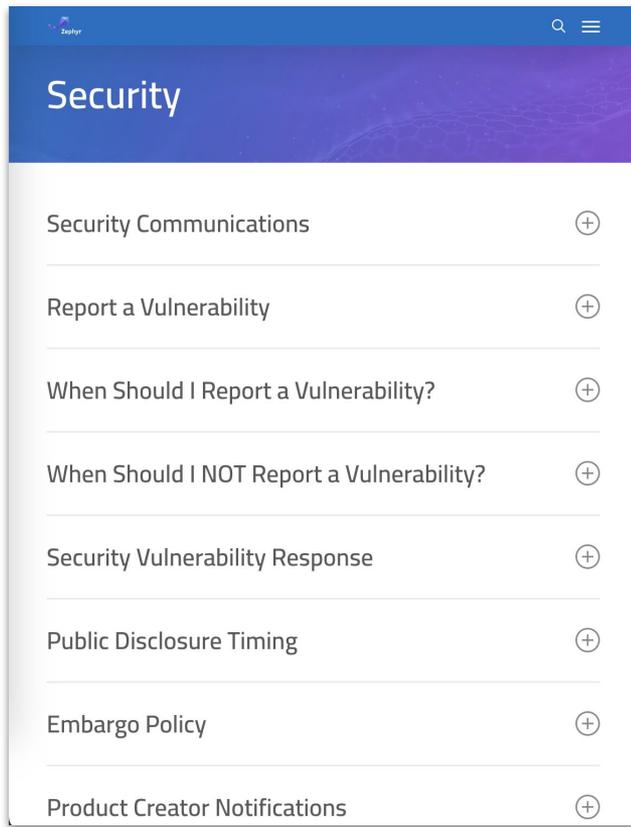
- Most issues were fixed in reasonable time and included in releases
- One issue, recommendation is to disable
- Increased embargo from 60 to 90 days
 - Zephyr isn't an end product, vendors need time to incorporate fixes into products
 - Zephyr needs alert system to notify vendors
- Continue to improve processes



Improving Processes...



- Highlighted need to better document process
- Added [vulnerability reporting](#) to project docs
- Added [security section](#) to main project page
- Process:
 - Embargo period extended
 - Stages issue goes through
 - Working with maintainers to see issues fixed
 - Public disclosure at end



Better Support for Product Makers



- For an embargo to work, product makers need to be notified early so they can remediate.
- Created [Vulnerability Registry](#) for vendors to register to receive these alerts for **free**
- **Goal:** Zephyr to fix issues within 30 days to give vendors 60 days before publication of vulnerability

Product Creators Vulnerability Alert Registry

If you believe your organization meets the criteria to be eligible to receive vulnerability alerts please fill out the form below.

Criteria for Participation

- Have a contact who will respond to emails within a week and understands how Zephyr is being used in the product.
- Have a publicly listed product based on some release of Zephyr.
- Have an actively monitored security email alias.
- Accept the Zephyr Embargo Policy that is outlined below.

Removal: If a member stops adhering to these criteria after joining the list then the member will be unsubscribed.

More information on Zephyr's Security and Disclosure practices can be found at [Security](#).

Source: <https://www.zephyrproject.org/vulnerability-registry/>

What we had to do before VEX...



Advisory Issued by project on 20201208:

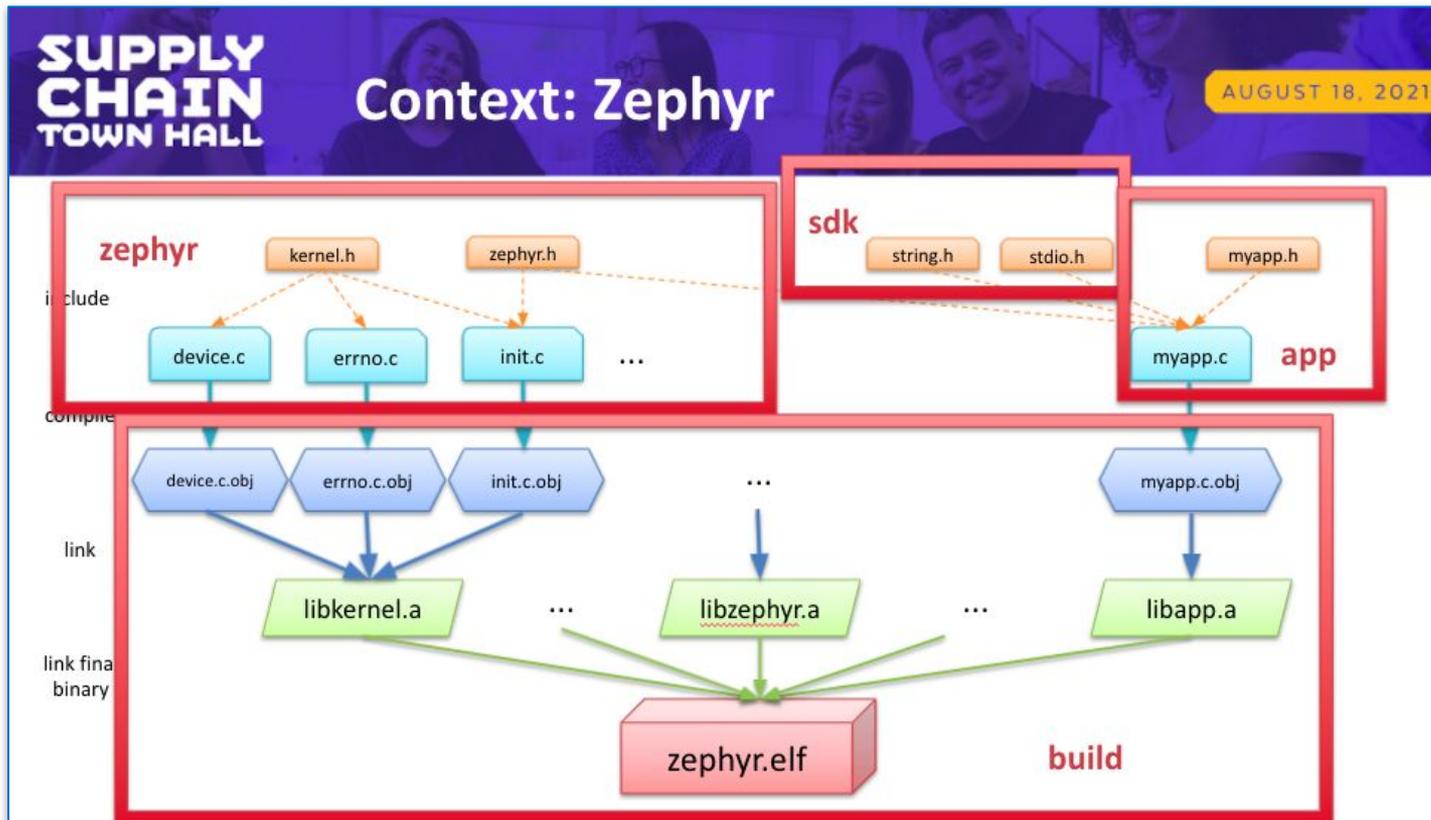
Zephyr current release (2.4) does **not use** Fnet or other stacks.

The Zephyr LTS release 1.14 contains an implementation of the TCP stack from Fnet.

- Of the vulnerabilities reported in Fnet, 2, [CVE-2020-17468](#), and [CVE-2020-17469](#), are in the IPv6 Fnet code, one, [CVE-2020-17467](#), affects Link-local Multicast Name Resolution (LLMNR), and 2, [CVE-2020-24383](#), and [CVE-2020-17470](#) affect DNS functionality.
- **None of the affected code has been used** in the Zephyr project, while 1.14 does use the Fnet TCP, it does not use the affected IPv6, DNS or LLMNR code.

<https://www.zephyrproject.org/zephyr-security-update-on-amnesia33/>

SBOM generation added in 2021



Learn more at: <https://www.youtube.com/watch?v=KYC3YpSu9zs>

Automated SBOM Generation During Build!



1. Create a build directory with CMake file API enabled
2. Build project with “build metadata” enabled
3. Compute SBOM(s)

```
west spdx --init -d BUILD_DIR
west build -d BUILD_DIR -- -DCONFIG_BUILD_OUTPUT_META=y
west spdx -d BUILD_DIR
```



| | |
|--------------------|---------------------------------------------------------------------------|
| zephyr.spdx | SBOM for the Zephyr source files actually used by your application |
| app.spdx | SBOM for the source files of your application |
| build.spdx | SBOM for all the build objects , inc. of course your final image |

SBOM's at Scale...Automatically



875 boards

13 apps

**All BUILT,
PASSED,
GENERATED**
have **3 SBOMs**
available to
download &
inspect

The screenshot shows the Renode Zephyr Dashboard interface. On the left is a sidebar with navigation options: ARCHITECTURE (ARC, ARM32, ARM64, MIPS, NIOS2, RISCV32, RISCV64, SPARC, X86, X86-64, XTENSA) and BUILD DETAILS (SHOW SIMULATION, B361C9589F, BE4DC048BD). The main area features a search bar and a table of boards. At the top right, summary statistics show: 539 PASSED, 503 PASSED, 432 PASSED, 517 PASSED, and 428 PASSED. The table columns are BOARD NAME, HELLO WORLD, PHILOSOPHERS, SHELL MODULE, TENSORFLOW LITE MICRO, and MICROPYTHON. The table is filtered to show ARM32 boards (656 total). One board, '96Boards Carbon [soc: nrf51822]', is highlighted with a 'Download SBOM' button. Other boards include '96Boards AeroCore2', '96Boards Argonkey', '96Boards Avenger96', '96Boards Carbon [soc: stm32f401xe]', '96Boards Meerkat96', '96Boards Neonkey', '96Boards Nitrogen', and '96Boards STM32 Sensor Mezzanine'.

| BOARD NAME | HELLO WORLD | PHILOSOPHERS | SHELL MODULE | TENSORFLOW LITE MICRO | MICROPYTHON |
|---------------------------------------------------------------------|-------------|--------------|---------------|-----------------------|-------------|
| ARC (20) | | | | | |
| ARM32 (656) | | | | | |
| 96Boards AeroCore2 st stm32f427vi | PASSED | PASSED | PASSED | PASSED | PASSED |
| 96Boards Argonkey st stm32f412Xg | PASSED | PASSED | PASSED | PASSED | PASSED |
| 96Boards Avenger96 st stm32mp157 | GENERATED | GENERATED | GENERATED | GENERATED | NOT BUILT |
| 96Boards Carbon [soc: nrf51822] nordic nrf51822_qfac | PASSED | PASSED | Download SBOM | PASSED | PASSED |
| 96Boards Carbon [soc: stm32f401xe] nordic nrf51822_qfac | PASSED | PASSED | PASSED | PASSED | PASSED |
| 96Boards Meerkat96 [soc: mcimx7d] [variant: m4] nxp nxp_imx7d_m4 | PASSED | PASSED | NOT BUILT | NOT BUILT | NOT BUILT |
| 96Boards Neonkey st stm32f411Xe | PASSED | PASSED | PASSED | PASSED | PASSED |
| 96Boards Nitrogen nordic nrf52832_qfaa | PASSED | PASSED | PASSED | PASSED | PASSED |
| 96Boards STM32 Sensor Mezzanine st stm32f446Xe | PASSED | PASSED | PASSED | PASSED | PASSED |

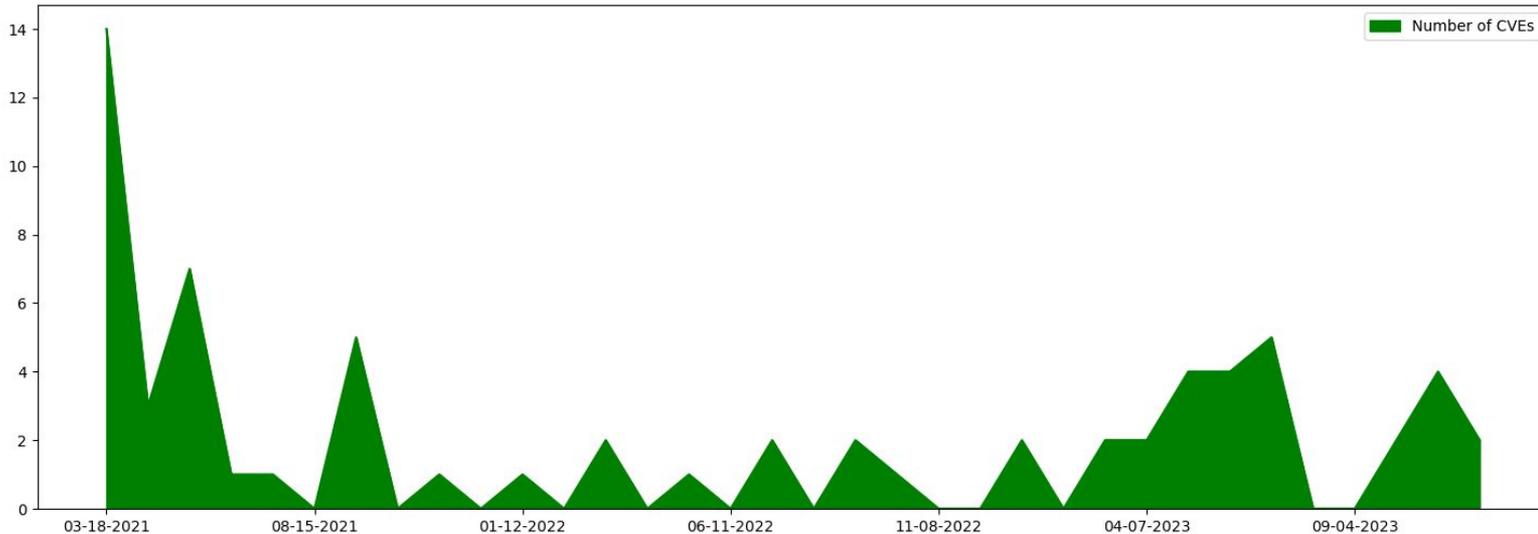
Source: <https://zephyr-dashboard.renode.io/>

Vulnerability Infrastructure → Github 2021

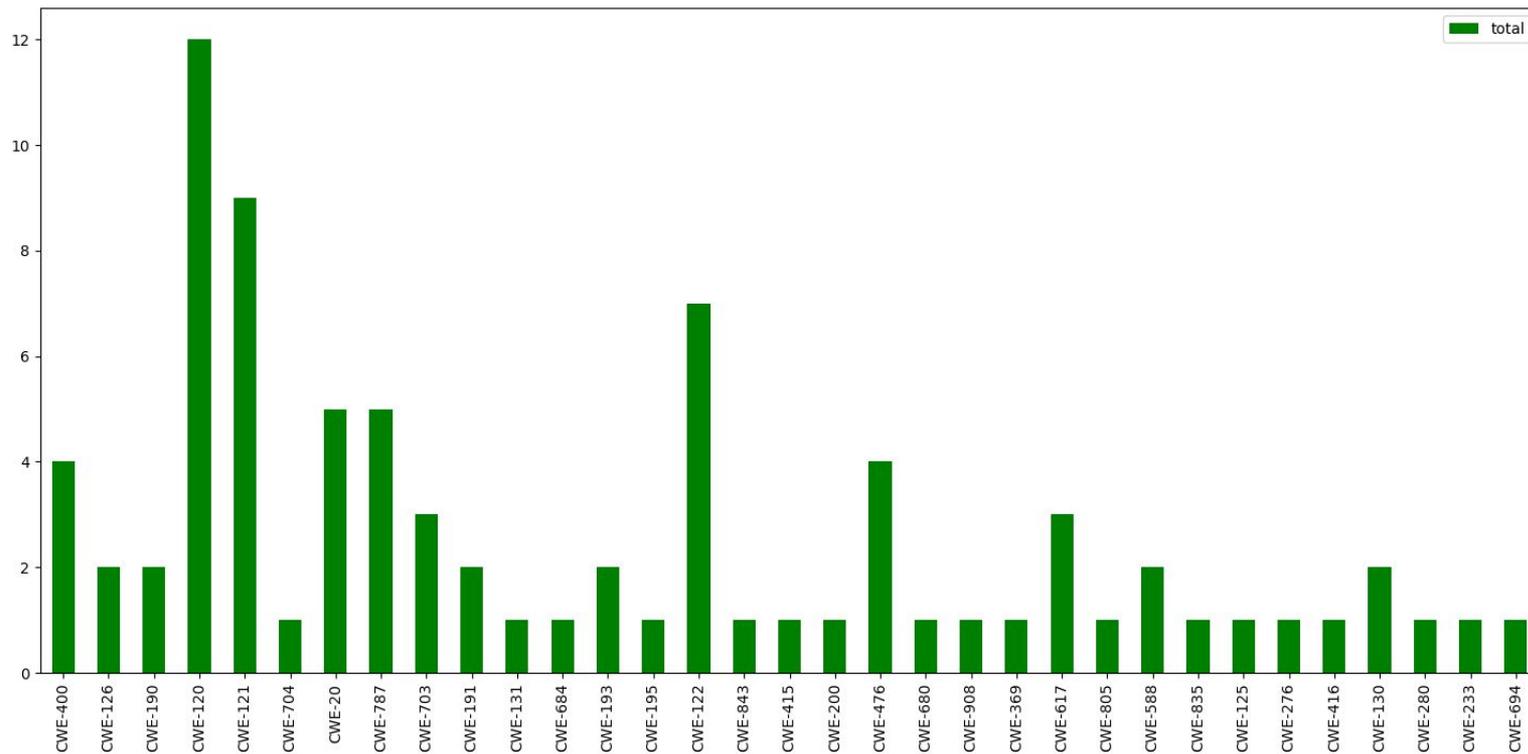
Why Transition?

Private repos became available. Better integration with rest of code.
No additional ids to manage. Improved analysis capabilities

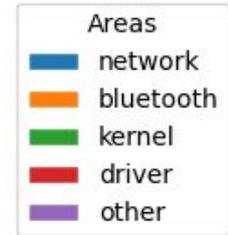
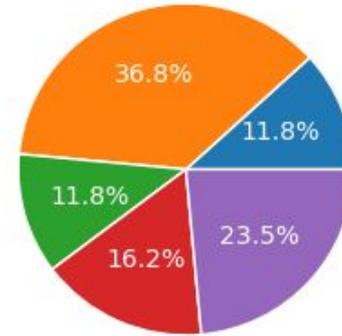
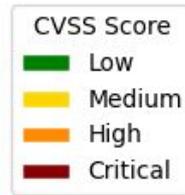
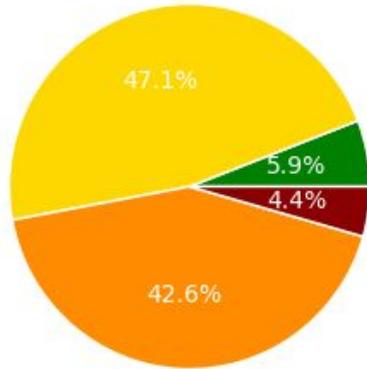
Total of CVEs published : 68 (since we started using github)



CWE Breakdown



Scoring & Code Area Breakdown



Security Working Group added March 2022



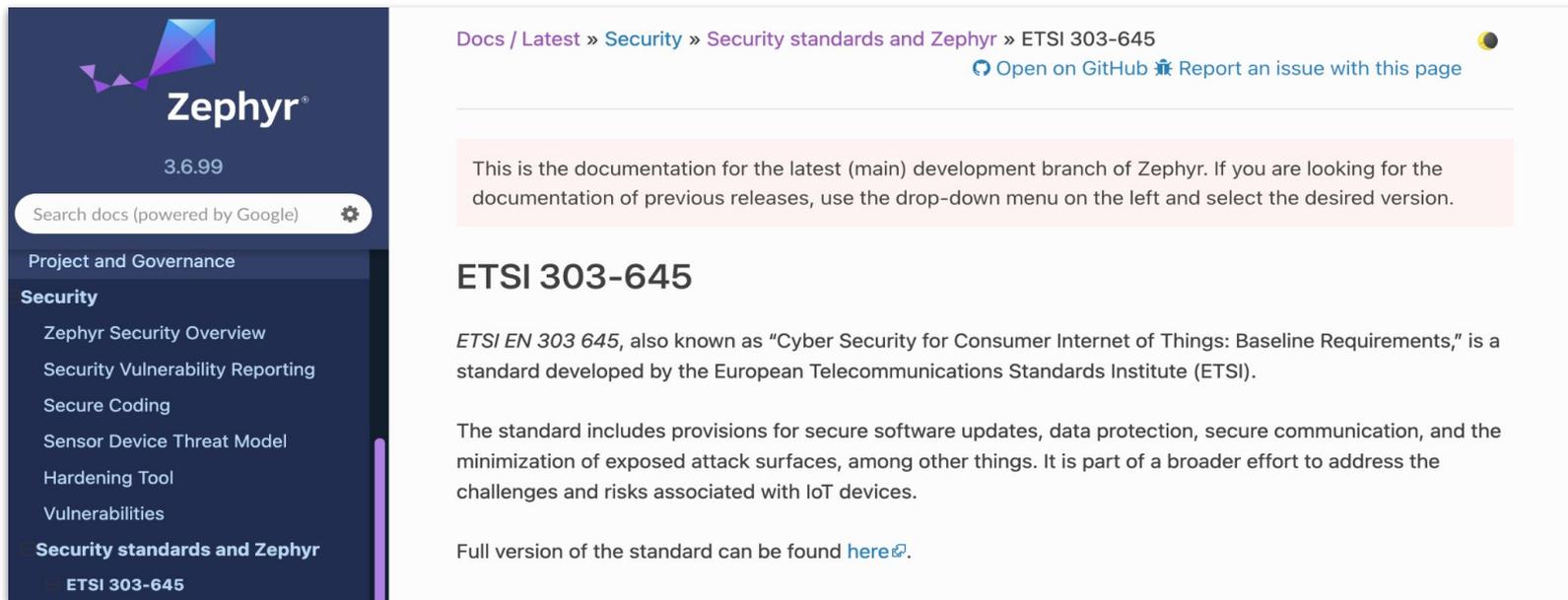
Security Committee

- **Restricted** to one representative from each platinum member, an architect (Flavio Ceolin), and a chair (David Brown)
- Meeting: Every 2 weeks
- Topics:
 - Vulnerabilities
 - PSIRT processes
 - Financial/contracts
 - Other sensitive information

Security Working Group

- **Open** to any participant
- Meeting: Every 2 weeks
- Topics:
 - Security Standards
 - ETSI EN 303-645
 - FIPS 140-3
 - SP 800-128
 - Annex K (C11 standard)
 - Evolving Security Processes
 - Code Analysis Tools
 - Documentation

Work on ETSI EN 303-645 in 2023

A screenshot of the Zephyr project's documentation website. The left sidebar is dark blue with the Zephyr logo and version number 3.6.99 at the top. Below the logo is a search bar and a settings gear icon. The sidebar menu includes "Project and Governance", "Security" (highlighted), and "Security standards and Zephyr" with "ETSI 303-645" selected. The main content area is white and shows the breadcrumb "Docs / Latest » Security » Security standards and Zephyr » ETSI 303-645" with links to "Open on GitHub" and "Report an issue with this page". A light pink box contains a note about the latest development branch. The main heading is "ETSI 303-645", followed by a paragraph explaining the standard's origin and a paragraph describing its scope. A link "here" points to the full version of the standard.

Docs / Latest » Security » Security standards and Zephyr » ETSI 303-645

[Open on GitHub](#) [Report an issue with this page](#)

This is the documentation for the latest (main) development branch of Zephyr. If you are looking for the documentation of previous releases, use the drop-down menu on the left and select the desired version.

ETSI 303-645

ETSI EN 303 645, also known as “Cyber Security for Consumer Internet of Things: Baseline Requirements,” is a standard developed by the European Telecommunications Standards Institute (ETSI).

The standard includes provisions for secure software updates, data protection, secure communication, and the minimization of exposed attack surfaces, among other things. It is part of a broader effort to address the challenges and risks associated with IoT devices.

Full version of the standard can be found [here](#).

Source: <https://docs.zephyrproject.org/latest/security/standards/etsi-303645.html>

Work on ETSI EN 303-645 in 2023



Zephyr
3.6.99

Search docs (powered by Google) 

Project and Governance

Security

- Zephyr Security Overview
- Security Vulnerability Reporting
- Secure Coding
- Sensor Device Threat Model
- Hardening Tool
- Vulnerabilities

Security standards and Zephyr

ETSI 303-645

Docs / Latest » Security » Security standards and Zephyr » ETSI 303-645

[Open on GitHub](#) [Report an issue with this page](#)

This is the documentation for
documentation of previous releases

ETSI 303-645

ETSI EN 303 645, also known as
standard developed by the European

The standard includes provisions for
minimization of exposed attack
challenges and risks associated

Full version of the standard can be

| | | | | |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------|-----|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Provision 5.6-3 | Device hardware should not unnecessarily expose physical interfaces to attack. | R | Y | Kconfig and Hardening Tool |
| Provision 5.6-4 | Where a debug interface is physically accessible, it shall be disabled in software. | M C | Y | Hardening Tool |
| Provision 5.6-5 | The manufacturer should only enable software services that are used or required for the intended use or operation of the device. | R | Y | Kconfig and Hardening Tool |
| Provision 5.6-6 | Code should be minimized to the functionality necessary for the service/device to operate. | R | Y | Kconfig |
| Provision 5.6-7 | Software should run with least necessary privileges, taking account of both security and functionality. | R | Y | Security Overview |
| Provision 5.6-8 | The device should include a hardware-level access control mechanism for memory. | R | Y | Memory protection |
| Provision 5.6-9 | The manufacturer should follow secure development processes for software deployed on the device. | R | Y | Security Overview and Coding guidelines |
| Provision 5.7-1 | The consumer IoT device should verify its software using secure boot mechanisms. | R | Y | Functionality provided by <i>MCUboot</i> < https://github.com/zephyrproject-rtos/mcuboot >. Also see Security Overview |

Source: <https://docs.zephyrproject.org/latest/security/standards/etsi-303645.html#provisions-assessment>

2024 Security Audit with NCC Group



Why External Audit?

- Identifying Vulnerabilities
- Independent Assessment
- Best Practices
- Community Trust
- Reputation

Scope Definition

- Security Objectives
- Components
 - Narrow to something doable and that benefits most users
- Depth of Analysis
- Threat Model

Results from NCCGroup

- Target Zephyr 3.6 / 3.7
 - 02/2024 ~ 03/2024
- Three issues found
 - Two low severity caused by integer overflow and TOCTOU
 - One informational caused by integer overflow

Lessons Learned from the Audit



Defining the scope is hard

- Resource Constraints
- Depth and Breadth
- Future-Proofing
- Stakeholder Agreement

Threat model is useful

- Guiding the Audit Process
- Validating Security Controls
- Facilitating Communication

Comprehensive testing importance

- The audit make it clear the importance of comprehensive testing

Outcomes:

- Enhanced Security
 - The identification and subsequent remediation of even low-severity issues contribute to a more secure system
- Increased Confidence
 - Third-party auditor validated the security and quality of the code base increasing confidence among developers, stakeholders, and users
- Recommendations aligned with Zephyr plans
 - Guided Fuzzing of Libraries and Subsystems

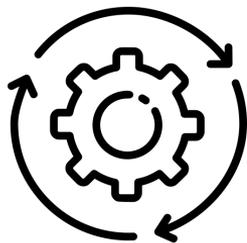
More Details Available...



Details at:

<https://www.youtube.com/watch?v=vEG-Oww9TEs&list=PLzRQULb6-ipHnRUuy2UlpqZjTM9FPWtWx&index=22>

Zephyr Security Summary



Weekly Coverity scans

MISRA scans

Automated Code checks
per pull request



[Documented secure coding practices](#)

Vulnerability response
criteria publicly
documented

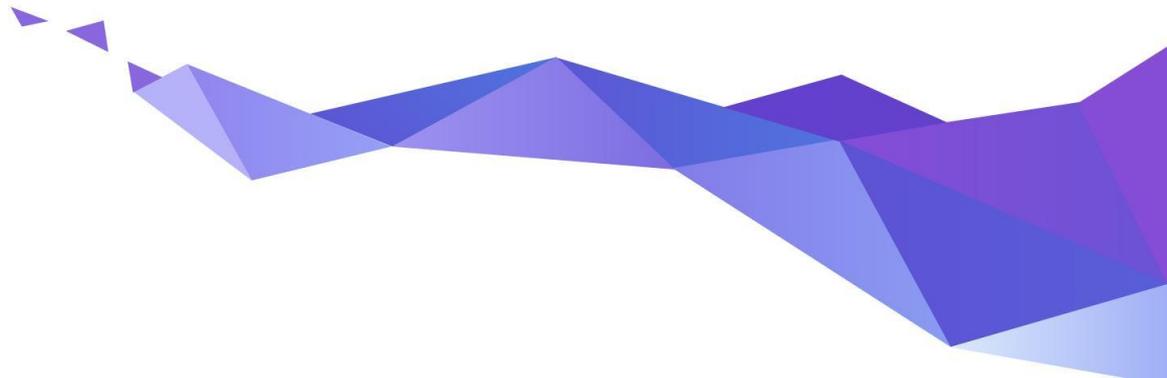


SBOM generation

per

[ISO/IEC 5962:2021](#)

What about Zephyr and safety?



Auditable

- An **auditable code base** will be established from a **subset of the Zephyr OS LTS**
- Code bases will be kept in sync
- More rigorous processes (necessary for certification) will be applied to the auditable code base.
- Processes to achieve selected certification to be:
 - Determined by Safety Committee and Security Committee
 - Coordinated with Technical Steering Committee



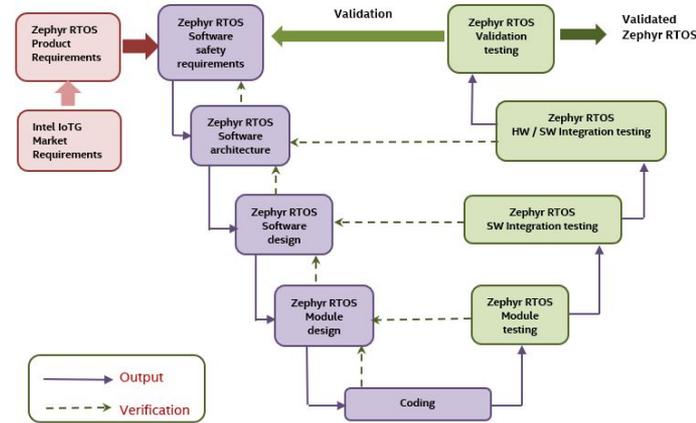
Compliant Development: V-model



It is difficult to map a stereotypical open-source development to the V-model

- Specification of features
- Comprehensive documentation
- Traceability from requirements to source code
- Number of committers and information known about them

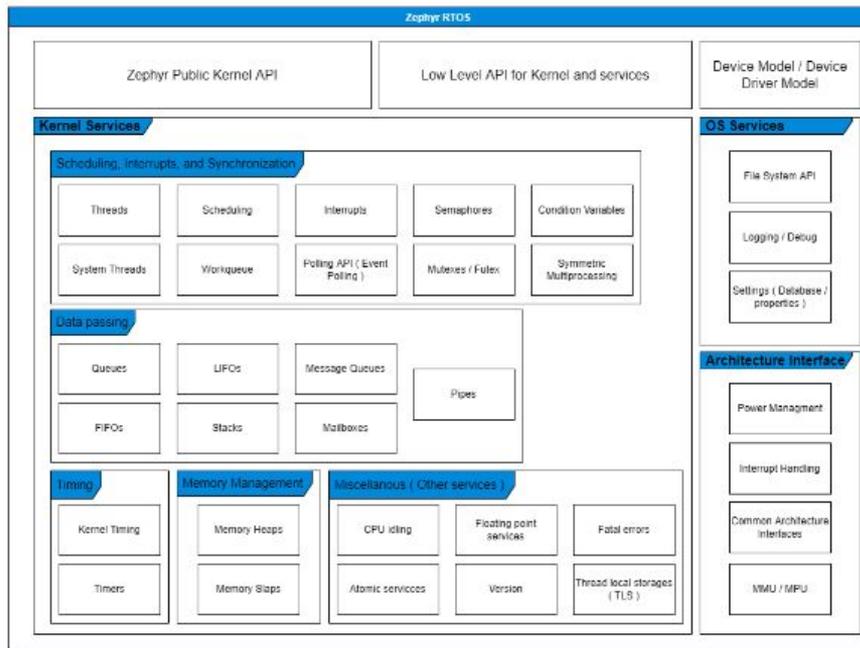
Zephyr RTOS functional safety work products mapping to IEC 61508-3 V model



⇒ Provide the evidences that open source developers can map to compliance and meet all requirements

Initial certification focus

- Start with a limited scope of kernel and interfaces
- Initial target is IEC 61508 SIL 3 / SC 3 (IEC 61508-3, 7.4.2.12, Route 3s)
- Option for 26262 ASIL D certification has been included in contract with certification authority should there be sufficient member interest



Scope can be **extended** to include **additional components** with associated **requirements** and **traceability** as determined by the safety committee

Safety Collateral Proposal



| Draft (Pending Approval by Certification Authority) | | | |
|--------------------------------------------------------------------|--------------|-------------------------|-------------------------------|
| Artifacts | Type of Doc | Owner | Work in progress Visibility |
| Plans | | | |
| Category | | | |
| Safety Development Plan | Plan/Process | Safety Committee | Public - Project Docs |
| Safety Assessment Plan | Plan/Process | FSM | Safety Committee Github |
| Verification / Validation / Integration Test Plan | Plan/Process | Testing WG | Public - Project Docs |
| Software Development Plan | Plan/Process | TSC | Public - Project Docs |
| Configuration and Change Management Plan | Plan/Process | TSC | Public - Project Docs |
| Coding Guideline | Plan/Process | TSC | Public - Project Docs |
| Tools Documentation | Plan/Process | TSC | Public - Project Docs |
| Specifications | | | |
| Category | | | |
| Safety Scope Definition | Spec. | Safety Committee | Safety Committee Github |
| Safety Software Requirement Specification (SRS) ** | Spec. | Safety Committee | Safety Committee Github |
| Safety Software Architecture and Interface Specification (SAIS) ** | Spec. | Safety Committee | Safety Committee Github |
| Safety Software Component Design Specification (SMDS) ** | Spec. | Safety Committee | Safety Committee Github |
| Safety Software Component Test Specification (SMTS) ** | Spec. | Safety Committee | Safety Committee Github |
| Safety Software Integration Test Specification (SITS) ** | Spec. | Safety Committee | Safety Committee Github |
| Safety Software Test Specification (STS) ** | Spec. | Safety Committee | Safety Committee Github |
| Sources | | | |
| Category | | | |
| Source Code | Source | TSC | Public |
| - Coding Guideline Compliance | Source | TSC | Public |
| Project Documentaton | Source | TSC | Public |
| - Software Requirement Specifications | Spec | TSC | Public |
| - Software Architecture and Interface Specification | Spec | TSC | Public |
| - Software Component Design Specification | Spec | TSC | Public |
| Project Testing | Source | TSC | Public |
| - Software Component/Unit Test Specification | Spec | TSC | Public |
| - Software Integration Test Specification | Spec | TSC | Public |
| - Software Test Specification | Spec | TSC | Public |
| - Tests | Source | TSC | Public |
| Reports | | | |
| Category | | | |
| Code Review Report (pre-merge) | Report | TSC | Public |
| Code Change Test Report (post-merge) | Report | Testing WG | Public |
| Test Coverage Report | Report | Testing WG | Public |
| Coding Guideline Compliance Report | Report | Safety WG & Security WG | Public |
| Traceability Report | Report | Safety WG | Public |
| Tools Classification | Report | Safety Committee | Public |
| Tools Validation | Report | Safety Committee | TBD (based on specific tools) |
| Fault Injection Test Report | Report | Safety Committee | Safety Committee |
| Safety Traceability Report (for Safety Scope) ** | Report | Safety Committee/FSM | Safety Committee |
| Safety Test Coverage Report (for Safety Scope) ** | Report | Safety Committee/FSM | Safety Committee |
| Safety Analysis (e.g., FMEA) | Report | FSM | Safety Committee |
| Manuals | | | |
| Category | | | |
| Software User Manual | Manual | TSC | Public |
| Safety Manual | Manual | FSM | Safety Committee |
| Certificates | | | |
| All safety certificates | Certificate | Safety Committee | N/A |

- Requirement definition, Source Code & Test linkage are **public**; and developed in open using [strictdoc](#)
- The set of requirements (and associated traceability) are applicable to safety scope is managed by the safety committee.
- Other project artifacts have owners designated.

What's happening now..

Safety Committee

- Safety Certification Strategy decisions
 - Scope of certification
 - Certification standards
 - Certification timeline
- Assessment and audit specific tasks
- Owner of certification artefacts and managing contract with certification authority
- Participation limited to the project's members, the safety architect and the functional safety manager

Safety Working Group

- Enabling safety qualifications/ certifications in the project
- Working on creating the required documentation and evidence in open
 - creating/deriving and documenting requirements
 - Linking requirements to code and tests
- Open to everyone to participate, join today:
<https://lists.zephyrproject.org/g/safety-wg>

Doulos, Honda, Hubble Network, IAR, inovex and Microchip Technology join the Zephyr Project as it gets Closer to Safety Certification

January 30, 2025

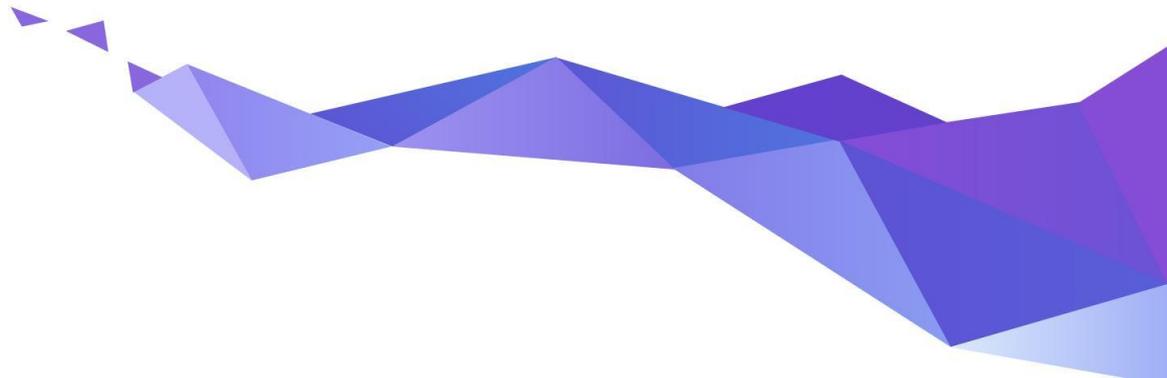
See Zephyr RTOS at FOSDEM on February 1-2

SAN FRANCISCO, January 30, 2025 – Today, [the Zephyr® Project](#) announced that [Doulos](#), [Honda](#), [Hubble Network](#), [IAR](#), [inovex](#) and [Microchip Technology](#) have joined as Silver members. Zephyr, an open source project at the [Linux Foundation](#) that builds a secure, connected and flexible RTOS for future-proof and resource-constrained devices, is easy to deploy and manage. It is a proven RTOS ecosystem created by developers for developers.

Last year, the project achieved several milestones including obtaining written concept approval for IEC 61508 certification of the Zephyr kernel. The Zephyr Project will continue to advance the functional safety and quality management processes for a safety element out of context (SEooC) that meets the requirements of the IEC 61508 standard, which is a globally recognized benchmark for ensuring the functional safety of systems, and a foundation for other safety standards. Compliance with IEC 61508 ensures that a system is developed and maintained with a rigorous approach to minimizing risks and increasing operational reliability. By integrating these processes into the development lifecycle, Zephyr aims to ensure traceability, transparency and accountability at every stage, from initial design to deployment and maintenance.

Source: <https://zephyrproject.org/doulos-honda-hubble-network-iar-inovex-and-microchip-technology-join-the-zephyr-project-as-it-gets-closer-to-safety-certification/>

Results from applying best practices?



New Products based on Zephyr



Otonon More
Hearing Aid



Lildog & Lilcat
Pet Tracker



Livestock Tracker



Moto Watch 100



Samsung Galaxy
Ring



Proglove



Adhoc Smart Waste



Google
Chromebook



Framework laptop



Keeb.io BDN9



Hati-ACE



Safety Pod



BLiXT solid state
circuit breaker



Aethero Deimos
Satellite



PHYTEC Distancer



Laird Connectivity
sensors & gateways



BeST pump
monitoring



Vestas Wind
Turbines

 zephyrproject.org/products-running-zephyr

Zephyr in the wild... 6.9K Forks!

About

Primary Git Repository for the Zephyr Project. Zephyr is a new generation, scalable, optimized, secure RTOS for multiple hardware architectures.

docs.zephyrproject.org

iot real-time microcontroller
embedded bluetooth bluetooth-le
mcu rtos zephyr zephyros
embedded-c zephyr-rtos

- Readme
- Apache-2.0 license
- Code of conduct
- Security policy
- Activity
- Custom properties
- 11.3k stars
- 407 watching
- 6.9k forks**
- Report repository

Releases 127

Zephyr 4.0.0 Latest
on Nov 15, 2024

+ 126 releases

Vestas Wind Systems A/S

 3 followers <http://www.vestas.com>

Popular repositories

zephyr Public
Forked from [zephyrproject-rtos/zephyr](#)

Primary Git Repository for the Zephyr Project. Zephyr is a new generation, scalable, optimized, secure RTOS for multiple hardware architectures.

● C ☆ 2 🍴 1

Source: <https://github.com/vestas-wind-systems>

Source: <https://github.com/zephyrproject-rtos/zephyr>

Supported Hardware Architectures



Cortex-M, Cortex-R
& Cortex-A



x86 & x86_64



32 & 64 bit

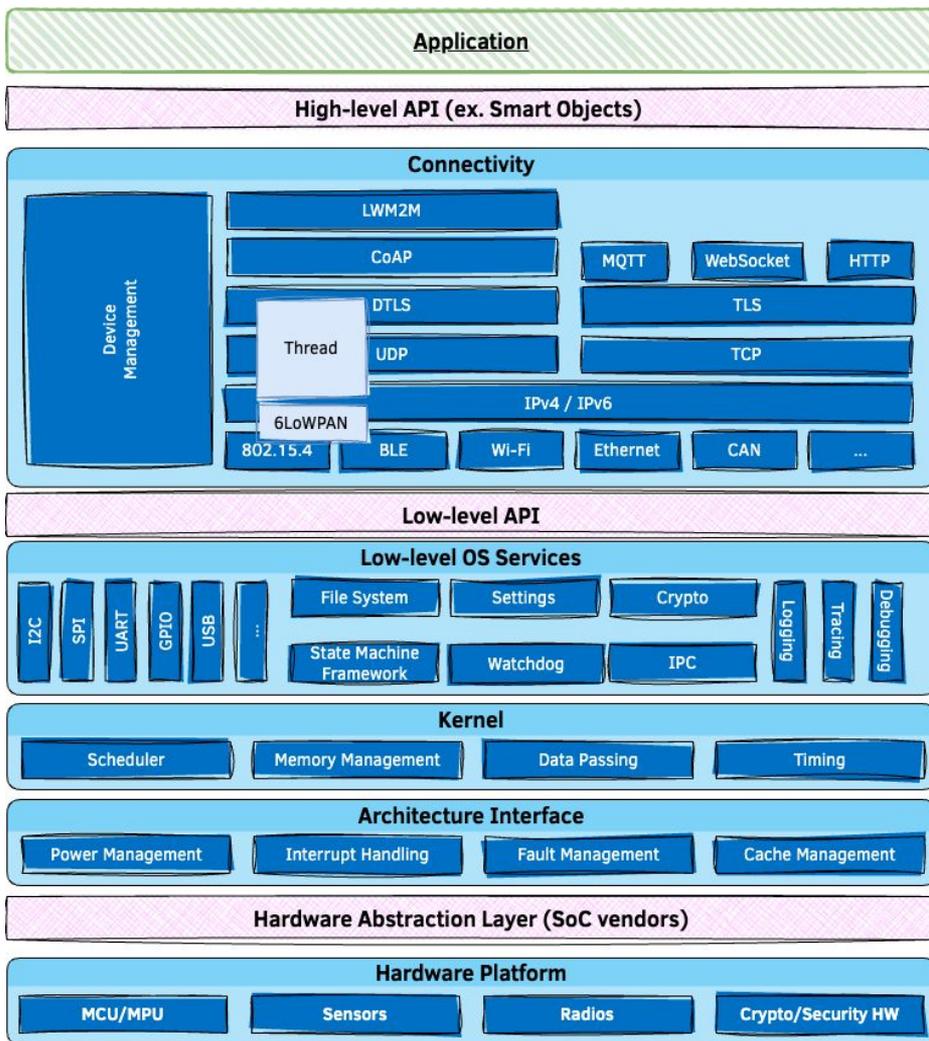


Xtensa



docs.zephyrproject.org/latest/hardware/index.html#hardware-support

Software Architecture



220+ Sensors Already Integrated

adt7420
adx1345
adx1362
adx1372
ak8975
amg88xx
ams_as5600
ams_iAQcore
apds9960
bma280
bmc150_magn
bme280
bme680
bmg160
bmi160
bmi270
bmm150
bmp388
bq274xx
ccs811

dht
dps310
ds18b20
ens
esp8266
fdd
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grove
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i2c720
icp1125
iis2dh
iis2dlpc



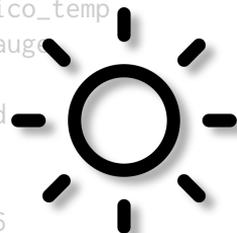
iis2iclx
iis2mdc
iis3dhhc
ina219
ina230
isl2935
ism330dhlx
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ite_vcmp_it8xxx2
lis2dh
lis2ds12
lis2dw12
lis2tr
lm75
lm77
lps22
lps22hh
lps25hb
lsm303dlhc_magn



lsm6ds0
lsm6dsl
lsm6dsx
lsm9ds0
lsm9ds0_mfd
max17055
max17262
max30101
max31875
max44009
max6675
mchp_tach_xec
mcp9804
mcp9805
mhz19
mpr121
mpu6050
mpu9250
ms5607
ms5837



nrf5
nuvoton_adc_cmp_npcx
nuvoton_tach_npcx
nxp_kinco
opt3001
pcnt_encoder3
pms7003
qdec_mcp
qdec_nrfx
qdec_sam
qdec_stm32
rpi_pico_temp
sbs_gaug
sgp40
sht3xd
sht4x
shtcx
si7006
si7055
si7060



si7210
sm3511t
stm32_temp
stm32_vbat
stmesc
stts751
sx9500
th02
ti_hdc
ti_hdc20xx
tmp007
tmp108
tmp112
tmp116
vcnl4040
vl53l0x
wsen_hids
wsen_itds

 github.com/zephyrproject-rtos/zephyr/tree/main/drivers/sensor

700+ supported boards... and growing



Arduino Portenta H7



ESP32



Sipeed HiFive1



nRF9160 DK



STM32F746G Disco



M5StickC PLUS



TDK RoboKit 1



BBC micro:bit v2



Blue Wireless Swan



Arduino Nano 33 BLE



Intel UP Squared



Dragino LSN50 LoRA Sensor Node



Microchip SAM E54 Xplained Pro Evaluation Kit



Raspberry Pi Pico



Altera MAX10



NXP i.MX8MP EVK



Adafruit Feather M0 LoRa

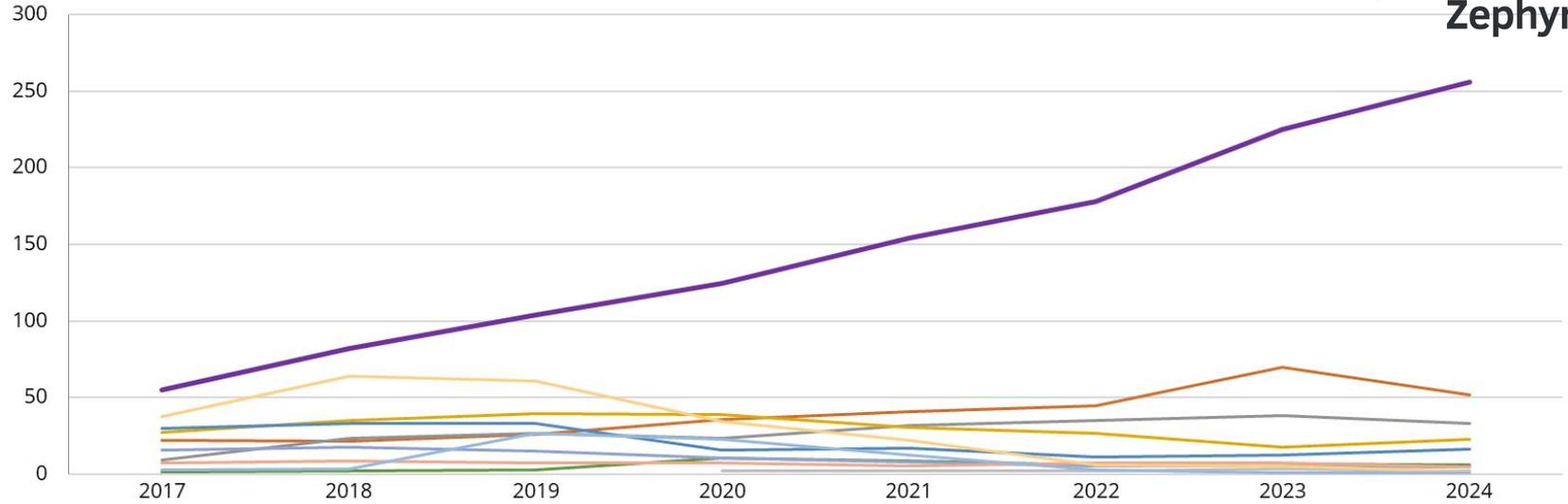


u-blox EVK-NINA-B3



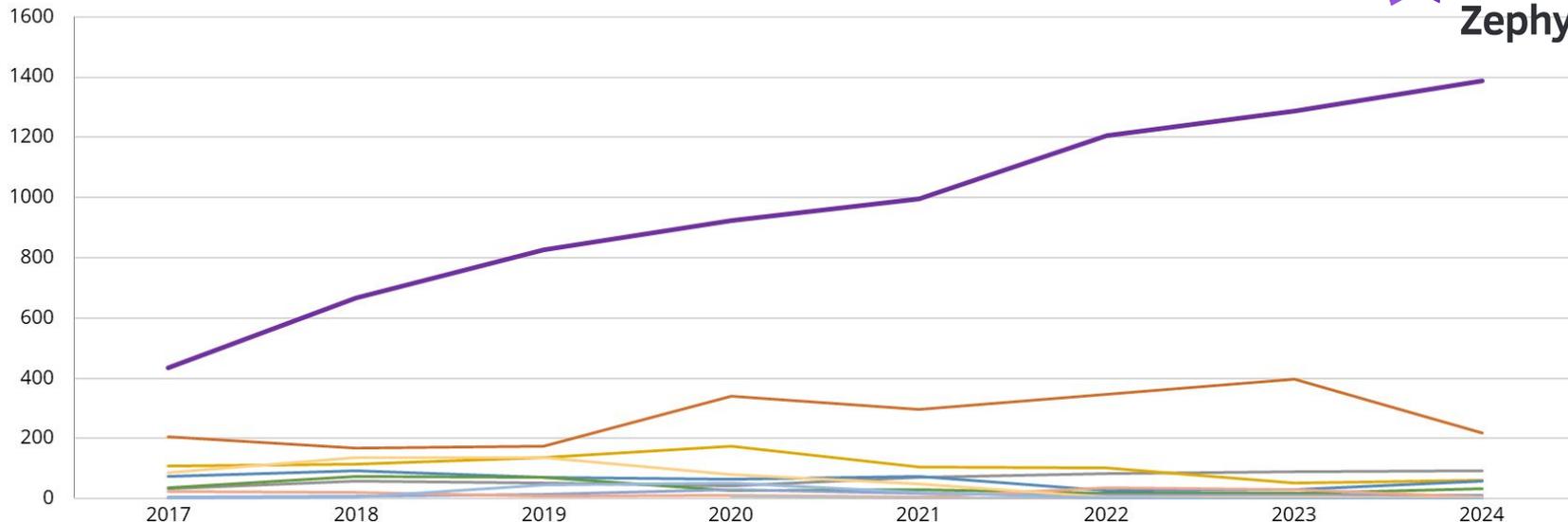
docs.zephyrproject.org/latest/boards

Average Number of Unique Contributors per Month



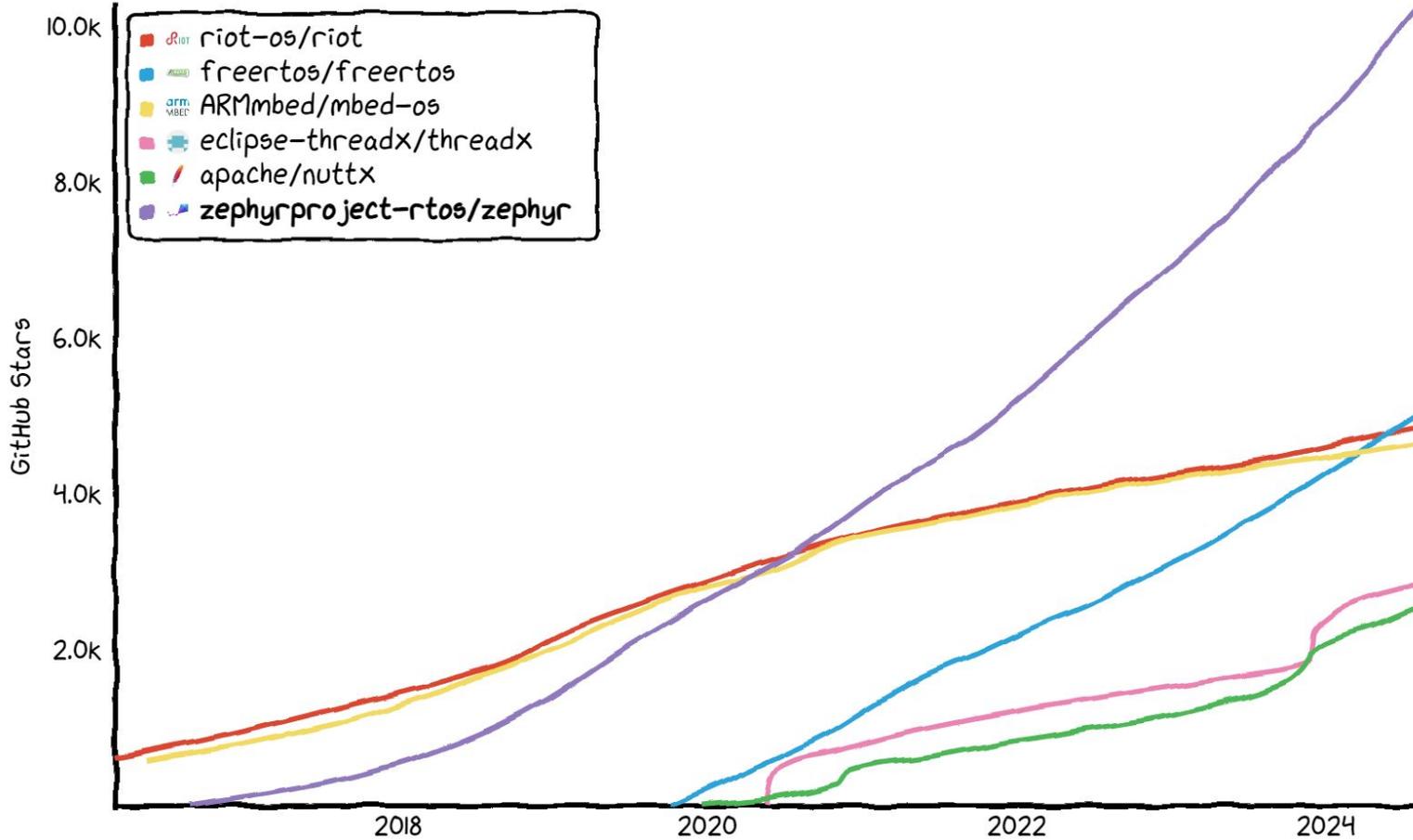
| | | | | | | | | |
|-----------------|----|----|-----|-----|-----|-----|-----|-----|
| Zephyr | 55 | 82 | 104 | 125 | 154 | 178 | 225 | 256 |
| Apache NuttX | 22 | 22 | 26 | 36 | 41 | 45 | 70 | 52 |
| RT-Thread | 9 | 24 | 26 | 23 | 32 | 35 | 38 | 33 |
| RIOT OS | 27 | 35 | 39 | 39 | 30 | 27 | 18 | 23 |
| TizenRT | 30 | 33 | 33 | 15 | 17 | 11 | 13 | 16 |
| FreeRTOS | 2 | 2 | 3 | 11 | 8 | 6 | 7 | 6 |
| Apache Mynewt | 16 | 18 | 15 | 11 | 8 | 5 | 5 | 5 |
| Contiki-NG | 8 | 9 | 7 | 7 | 5 | 7 | 7 | 5 |
| Eclipse ThreadX | | | | 2 | 2 | 2 | 3 | 2 |
| Arm Mbed OS | 38 | 64 | 61 | 35 | 22 | 6 | 5 | 2 |
| Amazon FreeRTOS | 3 | 3 | 27 | 23 | 13 | 3 | 1 | 1 |

Average Number of Commits per Month

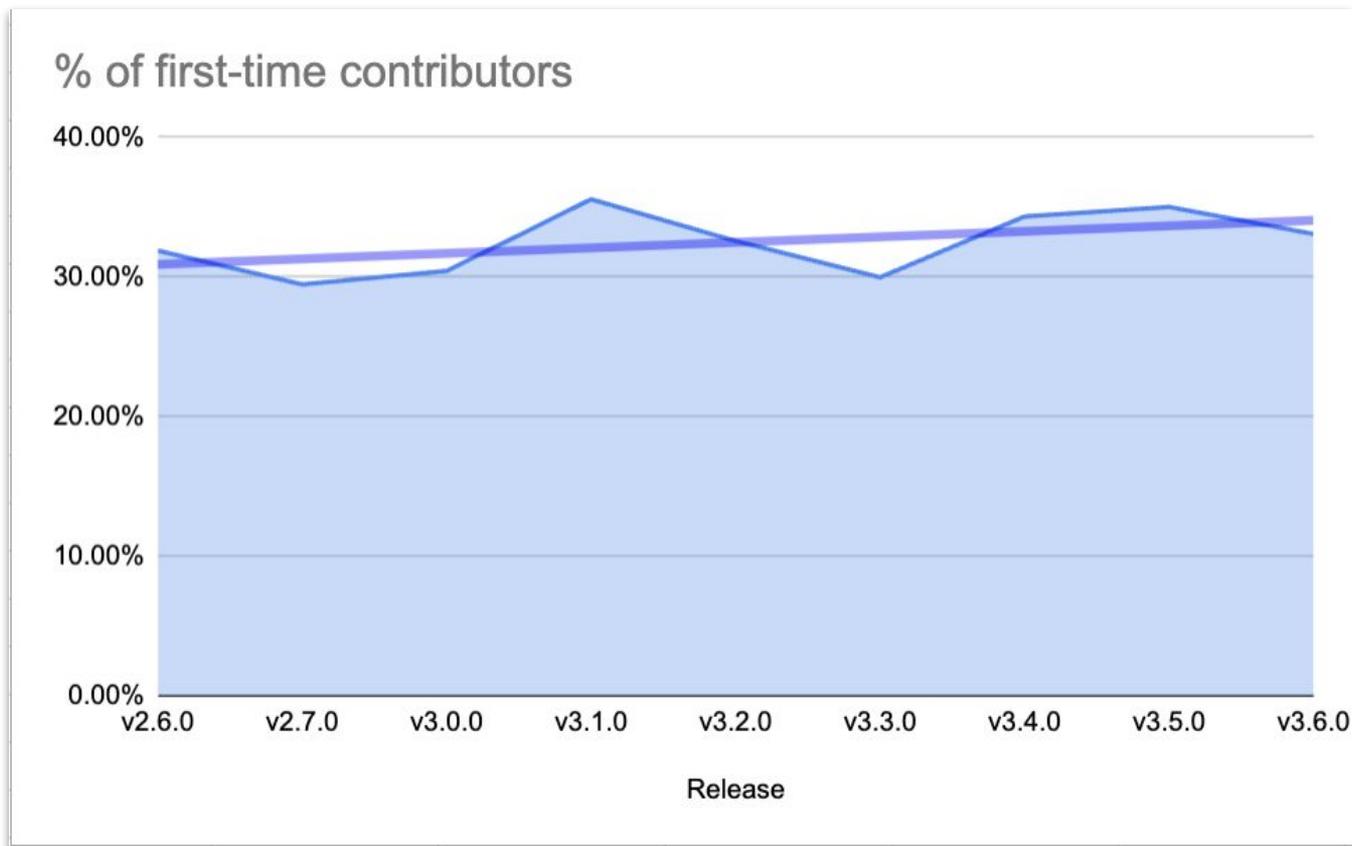


| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|-----------------|------|------|------|------|------|------|------|------|
| Zephyr | 434 | 667 | 825 | 924 | 995 | 1206 | 1287 | 1387 |
| Apache NuttX | 206 | 170 | 175 | 342 | 297 | 347 | 397 | 219 |
| RT-Thread | 35 | 59 | 53 | 43 | 70 | 84 | 91 | 92 |
| RIOT OS | 108 | 115 | 136 | 175 | 105 | 103 | 52 | 61 |
| TizenRT | 73 | 93 | 71 | 64 | 74 | 27 | 29 | 58 |
| Apache Mynewt | 38 | 74 | 70 | 27 | 31 | 18 | 19 | 33 |
| FreeRTOS | 4 | 8 | 13 | 32 | 17 | 11 | 12 | 11 |
| Contiki-NG | 23 | 22 | 9 | 11 | 7 | 38 | 30 | 6 |
| Eclipse ThreadX | | | | 7 | 1 | 2 | 3 | 2 |
| Arm Mbed OS | 86 | 136 | 138 | 82 | 51 | 6 | 5 | 2 |
| Amazon FreeRTOS | 2 | 4 | 47 | 53 | 20 | 2 | 0 | 0 |

Star History



New Contributors per Release

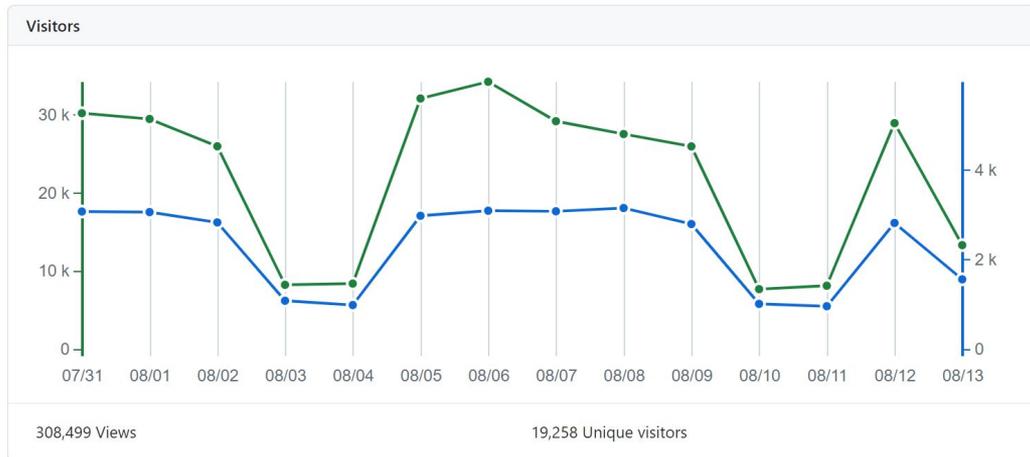


GitHub Clones & Unique Visitors

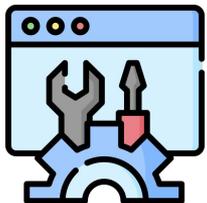


2024-07-31 → 2024-08-13

~186 unique clones per day
~1375 unique visitors per day



Vibrant Ecosystem



Development Tools



Zephyr[®]

Governing Board

Technical Steering Committee

Contributors



Applications & Middlewares



Training & Consulting



Firmwares & Libraries

Ecosystem // Developer Tools



Development Tools



Training & Consulting



Firmwares & Libraries

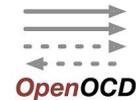


Applications & Middlewares

IDE



Compilers



Emulation / Simulation



Ecosystem // Training & Consulting



Training



Services & Consulting



Development Tools



Training & Consulting



Firmwares & Libraries



Applications & Middlewares

Ecosystem // Firmwares & Libraries



Development Tools



Training & Consulting



Firmwares & Libraries



Applications & Middlewares

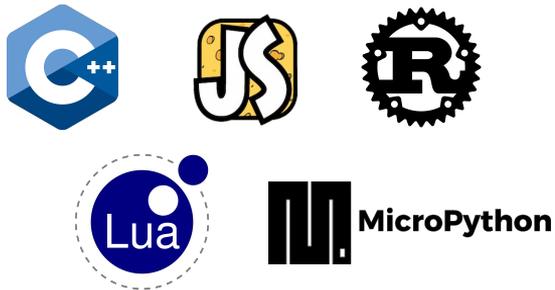
Security



TinyML



Language runtimes



Others



Ecosystem // Apps & Middlewares



Development Tools



Training & Consulting



Firmwares & Libraries



Applications & Middlewares

Remote Management



Graphical Interfaces



Robotics



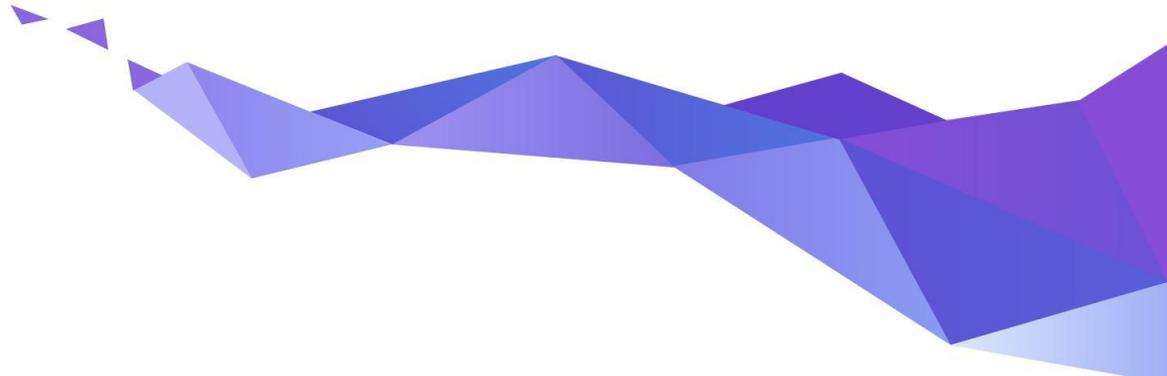
Zephyr Project: Platinum Members



Zephyr Project: Silver Members



What's next?



Focus areas:



- Impact of growth on Maintainers
- Project driven benchmarking
- Test infrastructure rework
- CRA readiness
- Domain expertise for requirement formulation

Improving Contributor Diversity



Short Survey (inspired by Rust survey) at:
<https://linuxfoundation.research.net/r/zephyr-diversity>

Zephyr Participation Information



zephyrproject.org



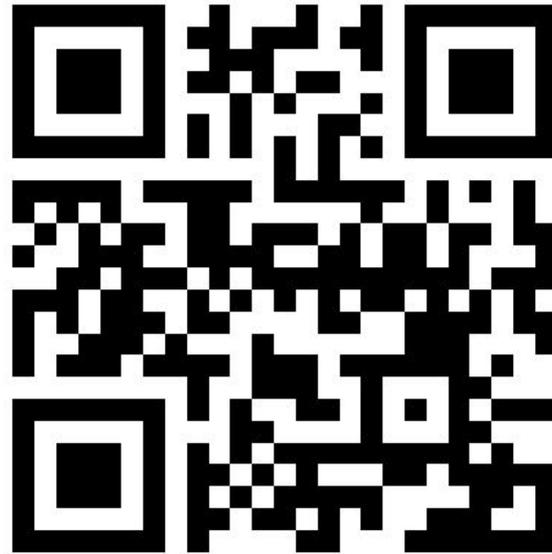
github.com/zephyrproject-rtos



lists.zephyrproject.org



chat.zephyrproject.org



zephyrproject.org