

Zephyr RTOS: 10 Years After Applying OSS Best Practices

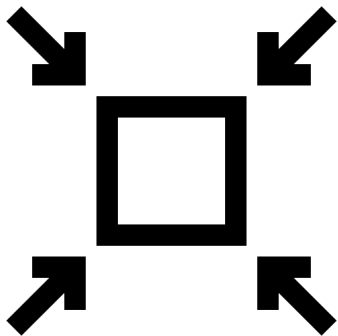
서울

Kate
VP Dependable Embedded S
kstewart@linuxfounda



Use Cases for a Real-Time OS



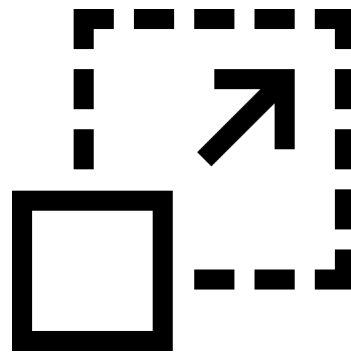


SMALL

< 8KB Flash

< 5KB RAM

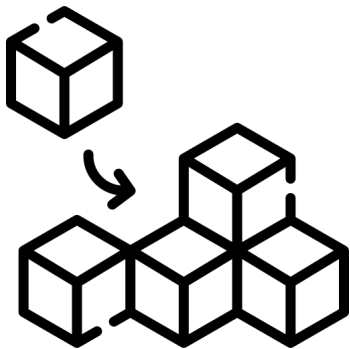
yet



SCALABLE

from small sensor nodes

... to complex multi-core systems



FLEXIBLE

yet



SECURE

Heavily customizable

Out-of-the-box support for
1000+ boards and 100s of sensors

Built with safety & security in mind

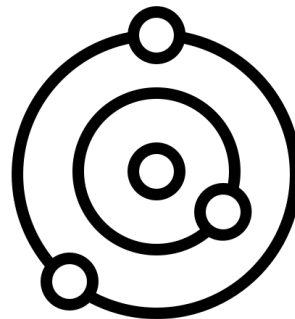
Certification-ready
Long-term Support



OPEN-SOURCE

Permissively licensed (Apache 2.0)

Vendor-neutral governance



ECOSYSTEM

Vibrant community

Supported by major silicon vendors

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

Boards Supported (5 → 1000+)

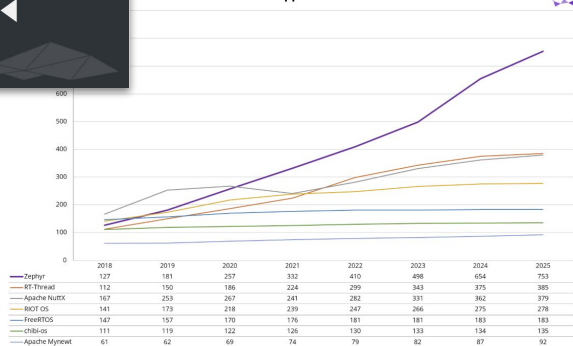


Supported Platforms

Arduino 101 Quark D2000 CRB Galileo Gen2 FRDM-K64F Arduino Due

► More platforms and boards to follow ◀

Number of Supported Boards



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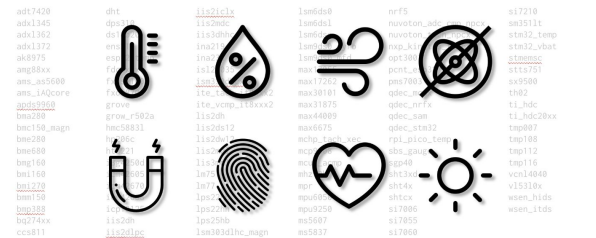
Note: Only the operating systems for which number of supported boards could be easily computed automatically are included on this chart.

1000+ supported boards... and growing



docs.zephyrproject.org/latest/boards/

300+ Sensors Already Integrated



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

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Zephyr[®]



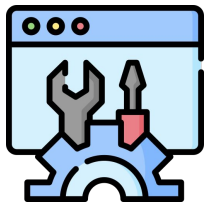
Governing Board



**Technical Steering
Committee**



Contributors



Development Tools



Governing Board

**Technical Steering
Committee**

Contributors



**Applications &
Middlewares**



**Training &
Consulting**



**Firmwares &
Libraries**

Lessons Learned by Linux Developers circa 2016/2017

Linux Kernel Development Report

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

Source:

<https://www.linuxfoundation.org/resources/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

Linux Best Practice	Zephyr Adoption
Vendor Neutral Decision Making	Yes, Project support from multiple companies.
Companies and Individuals Participate	Yes, TSC has companies & community participation.
Streamline upstreaming process	Yes, see / CONTRIBUTING.rst , DCO used
Public code reviews?	Yes, issues & pull requests reviewed on https://github.com/zephyrproject-rtos/zephyr
Consensus Oriented Decision Models	Yes, TSC votes on features & release readiness.
Hierarchical development (Maintainers)	Yes, see / MAINTAINERS.yml
No Internal Boundaries	Yes, anyone can make pull request for any area
Distributed version control	Yes, see / CONTRIBUTING.rst
Short Release Cycle (w/ Merge Window)	Sort of, Evolved to 5 month merge, 3 week stabilize
Long Term Support Releases	Yes, LTS 3 active maintain

Security Best Practice Evolution

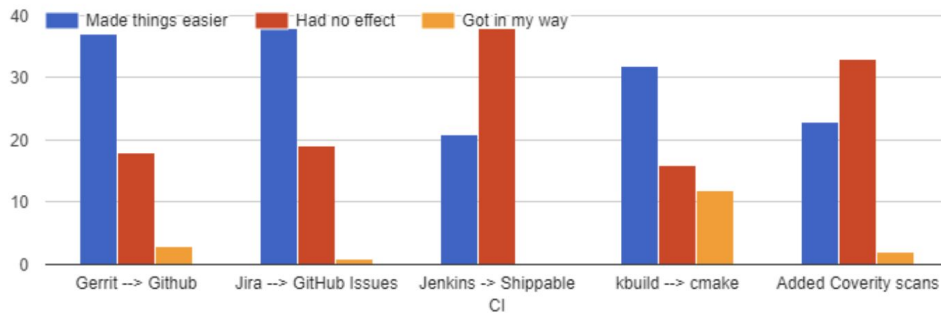


- Established Security Committee at project launch in 2016 – meets bi-weekly.
- Secure Coding Practices were publicly [documented](#) for project.
- Zephyr Project [registered as a CVE Numbering Authority](#) with MITRE since 2017.
- [“Gold” Best Practices Badge](#) criteria Core Infrastructure Initiative met in 2018
- Vulnerability Management Process in 2020
 - Vulnerability response criteria publicly documented
 - Product makers can register for free for embargo notifications Zephyr
- Automatic SPDX SBOM generation added 2021
- Infrastructure transition to github in 2021, improved automation & interaction with CVE
- Security working group formation in 2022 to improve transparency with community
- Work on self attestation for ETSI 303-645 started in 2023
- Project funded Audit by NCC group in 2024
- Documented CRA Readiness in 2025

Developer Surveys Started in 2018

Results

In 2017, we made significant changes to the infrastructure of the project.
Have these changes impacted your ability to contribute to the project?



Source: [2018 Zephyr Developer Survey Results](#)

→ Annual Developer Surveys



Developer Survey 2026 Overview



2026 - 523 Responses

- TSC Voting: 30
- Maintainer: 97
- Collaborator: 130

Geography: 56% Europe, 22% APAC, 15% North America, 3% Latin America & Caribbean, 3% Middle East, 1% Africa.

Experience: 54% Respondents have >5 years experience

High Level Summary for 2026:

- 84% positive about Zephyr, 11% neutral, 5% negative.
- 88% contribute to Zephyr as part of their job

2025 - 208 Responses

- TSC Voting: 19
- Maintainer: 38
- Collaborator: 39

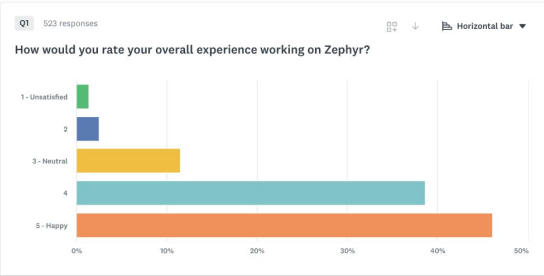
Geography: 57% Europe, 20% North America, 16% Asia (includes India & Pakistan), 4% South America, 2% Oceania, 1% Africa

Experience: 55% Respondents have >5 years experience

High Level Summary for 2025:

- 80% positive about Zephyr, 12% neutral, 8% negative.
- 86% contribute to Zephyr as part of their job

1. How would you rate your overall experience working on Zephyr?



2025 (208)

- 80% positive
- 12% neutral
- 8% negative.

2024 (152)

- 84% positive
- 13% neutral
- 3% negative.

2023 (403)

- 81% positive
- 14% neutral
- 5% negative.

2026 (523)

- 85% positive (443)
- 11% neutral (60)
- 4% negative (20)

2022 (93)

- 90% positive
- 8% neutral
- 2% slightly negative.

15. Which Zephyr technical shortcoming should be addressed most urgently? *free-text comments; n = 198*



- **Driver / peripheral / sensor coverage** breadth and depth
 - "many boards/SoCs are 'supported' but only minimally — peripherals/features missing."
- **Build system — Devicetree / Kconfig / CMake / West**
 - "DTS is still garbage."
 - "The Kconfig mess... menuconfig is difficult for newcomers."
- **Functional safety / certification**
 - "A safety certification would be a game-changer for many users/projects."
- **Networking / connectivity:** Matter, WiFi/ESP32, Thread, LoRa, sub-GHz
- **Out-of-tree modularity:** plugins, HAL decoupling, vendor SDKs
 - "improve modularity: out-of-tree drivers, SoCs, boards, HALs — without patching Zephyr."

Source: [2026 Zephyr Developer Survey Results](#)

And the results of applying these
best practices?

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	3,503	436	147,809	3,331
nuttX	2007/?	community	BSD-variant → Apache-2.0	736	59	62,681	569
RIOT	2010/09	community	LGPL-2.1	390	32	50,126	160
RT-Thread	2009/06	community	GPL-2.0 → Apache-2.0	823	23	18,104	76
Tizen RT	2015/04	Samsung	BSD-variant → Apache-2.0	237	17	12,473	35
myNewt	2015/06	community	Apache-2.0	142	8	11,585	16
FreeRTOS	2004/07	Richard Barry	GPL-2.0 w/ FreeRTOS → MIT	248	8	3,673	8
Contiki-NG	2017/10	community	BSD-3-Clause	223	8	18,492	75
SeL4	2014/07	community	GPLv2 AND BSD-2-Clause	125	7	4,967	38
Ariel-OS	2020/08	community	Apache-2.0 OR MIT	32	6	4,998	28
ThreadX	2020/05	MSFT → community	MSL → MIT	42	0	338	0

Data extracted on 2026-08-09 from github

Methodology: Sample from Github

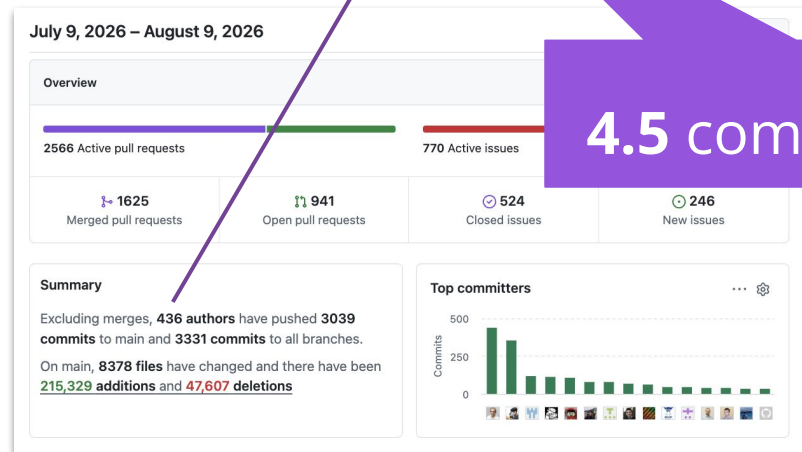


<https://github.com/zephyrproject-rtos/zephyr>

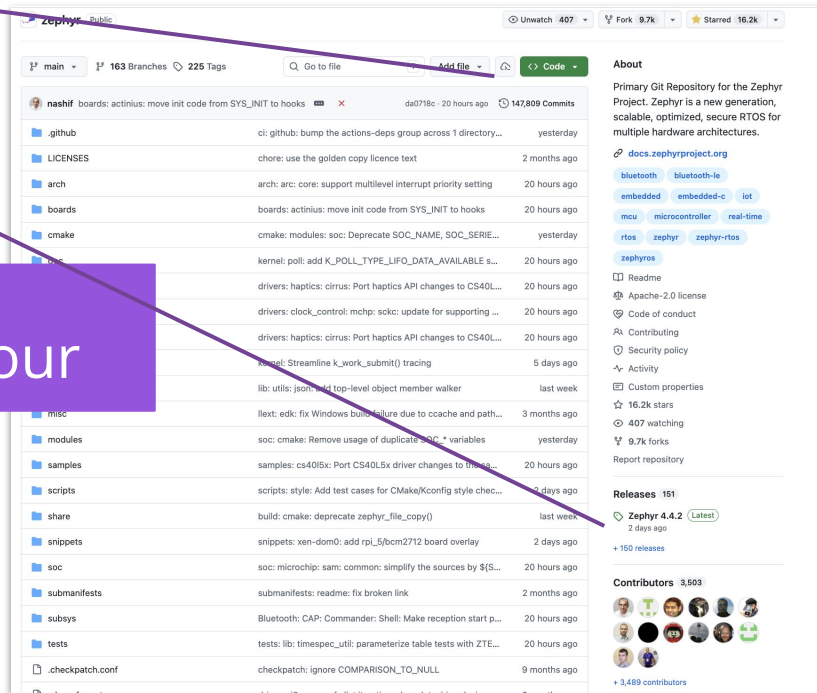
- Total commits: 147,809
- Total contributors: 3,503

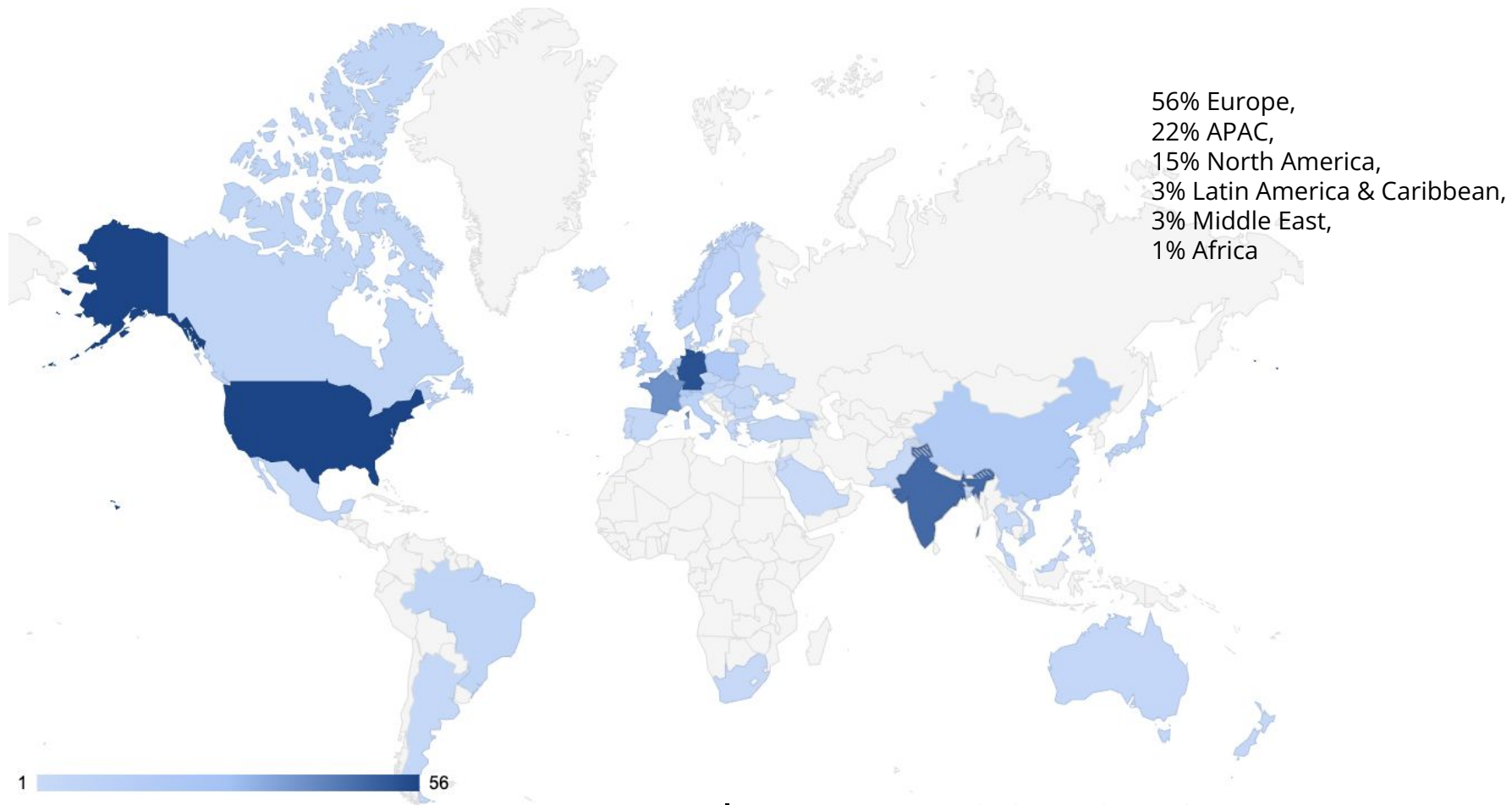
<https://github.com/zephyrproject-rtos/zephyr/pulse?period=monthly>

- Monthly contributors: 436
- Monthly commits: 3,331



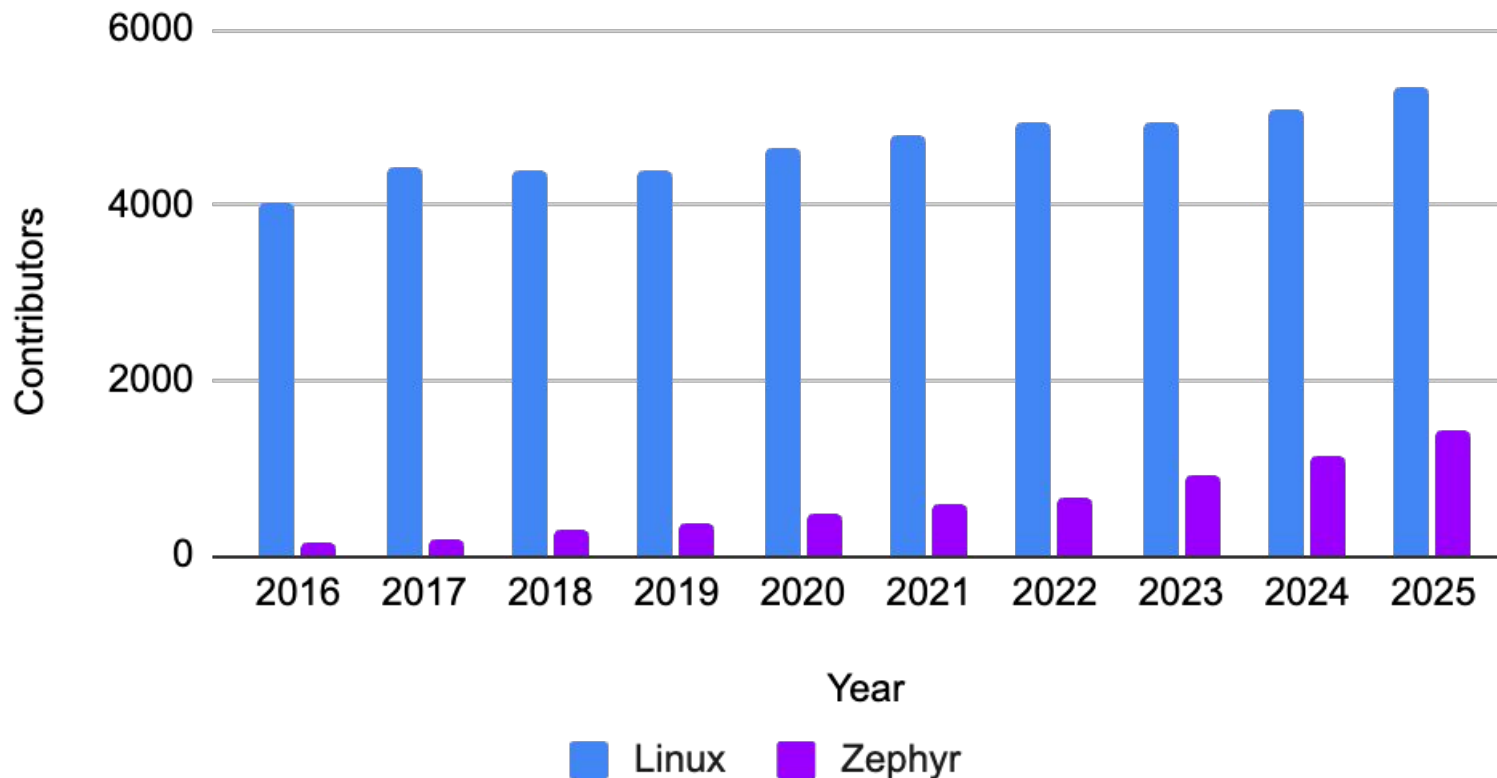
4.5 commits/hour



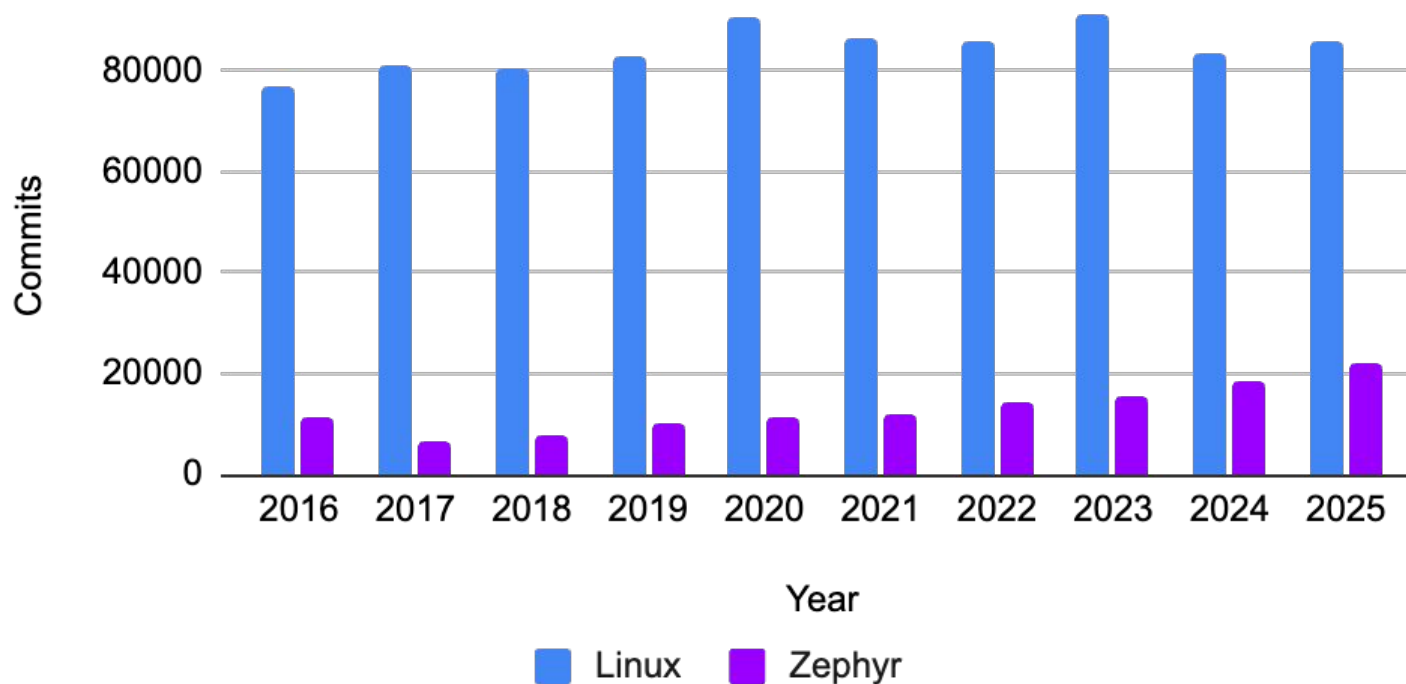


Developers Participating in 2026 Survey

Contributors Per Year Over Time (2016-2025)



Commits Per Year Over Time (2016-2025)



Small Sample of Products Running Zephyr Today



**Oticon More
Hearing Aid**



**HALO
Smartglasses**



Livestock Tracker



Moto Watch 100



**Dandelion
PulseTape ECG**



Proglove



Adhoc Smart Waste



**Google
Chromebook**



Framework laptop



Keychron Q11



Hati-ACE



**Blackhole™
PCIe AI Accelerator**



**BLiXT solid state
circuit breaker**



**Aethero Deimos
Satellite**



**BAUER NE
Bluetooth
SmartLock**



**Laird Connectivity
sensors &
gateways**



**BeST pump
monitoring**



**Vestas Wind
Turbines**



zephyrproject.org/products-running-zephyr

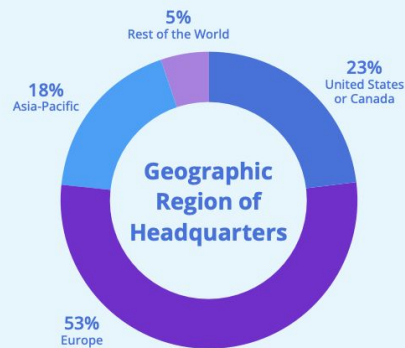
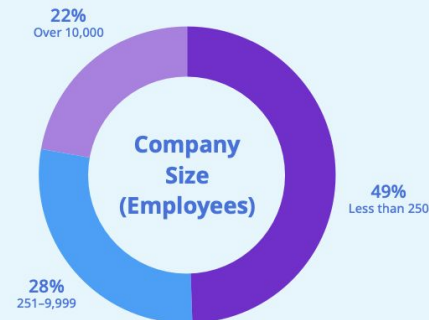
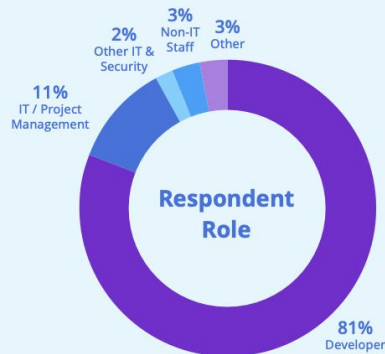
Research Report Released 2026-3-4



linuxfoundation.org/research/zephyr-turns-10

FIGURE 38

Respondent demographics



ZEPHYR® TURNS 10



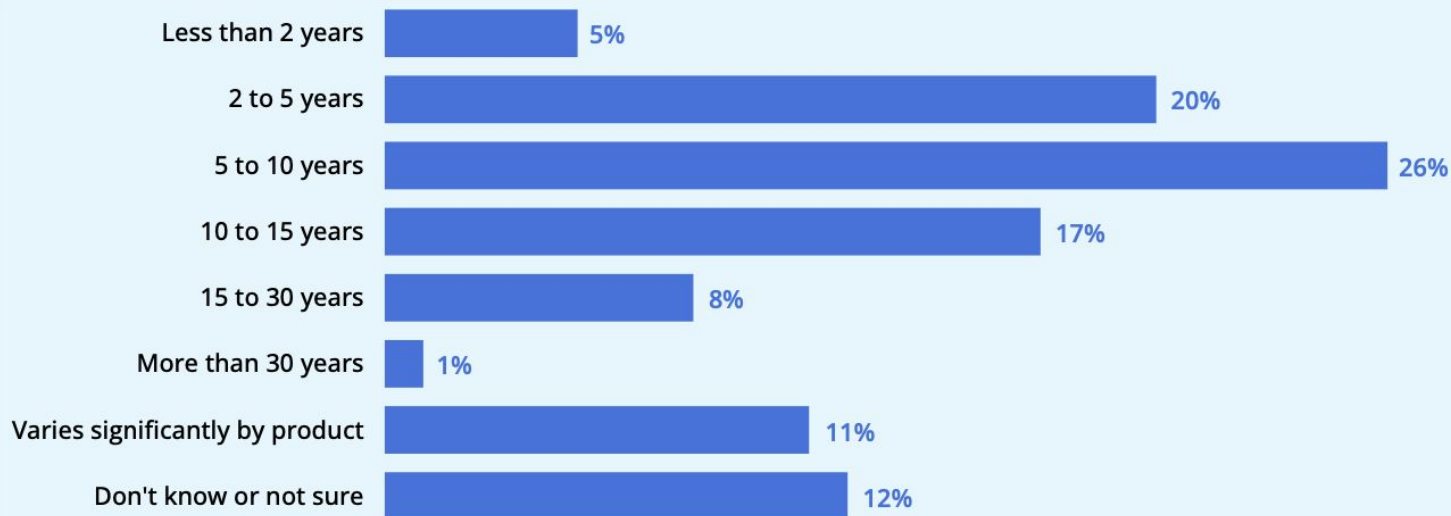
**Experts confirm
Zephyr's maturity:**
now production-ready with
stable stacks, and suitability
for long-lifecycle industrial
devices requiring decades
of operation.

Lifecycle & Support Window distribution

FIGURE 4

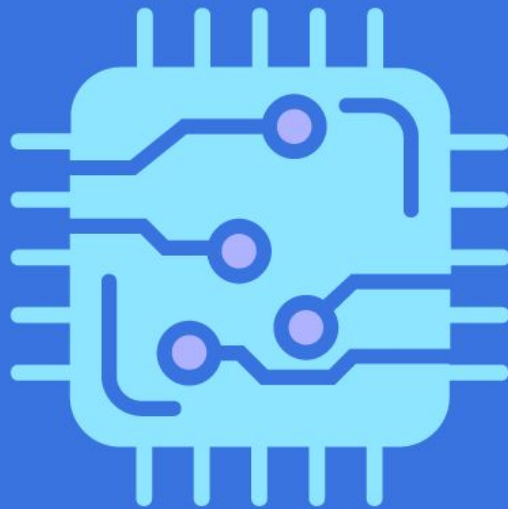
What is the typical lifecycle/support duration for your embedded products?

Zephyr Turns 10 Survey, Q12, Sample Size = 400



ZEPHYR® TURNS 10

**79% of respondents
report improved
hardware** and board
support, and 60% report
improved connectivity
since adopting Zephyr.



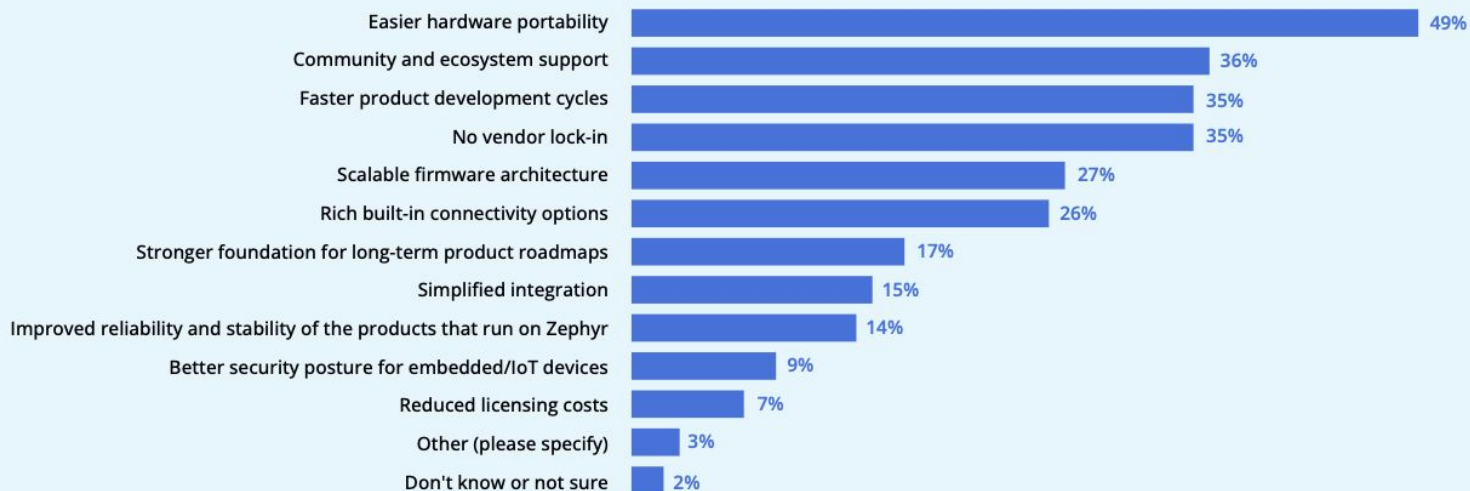
Why use Zephyr?



FIGURE 19

In your opinion, what are the biggest impacts of using Zephyr?

Zephyr Turns 10 Survey, Q32, Sample Size = 227, Total Mentions = 623



“When we had to redesign control modules due to processor obsolescence, Zephyr gave us a scalable foundation for an entire family of products. Its cross-vendor and cross-MCU design allowed us to port to new SoCs quickly while keeping a layered, reusable firmware architecture.”

— HENRIK BRIX ANDERSEN, LEAD EMBEDDED
SOFTWARE ENGINEER, VESTAS WIND SYSTEMS A/S

What Hardware Platforms?

FIGURE 15

What types of hardware platforms does your organization use with Zephyr?

Zephyr Turns 10 Survey, Q28, Sample Size = 230, Total Mentions = 433

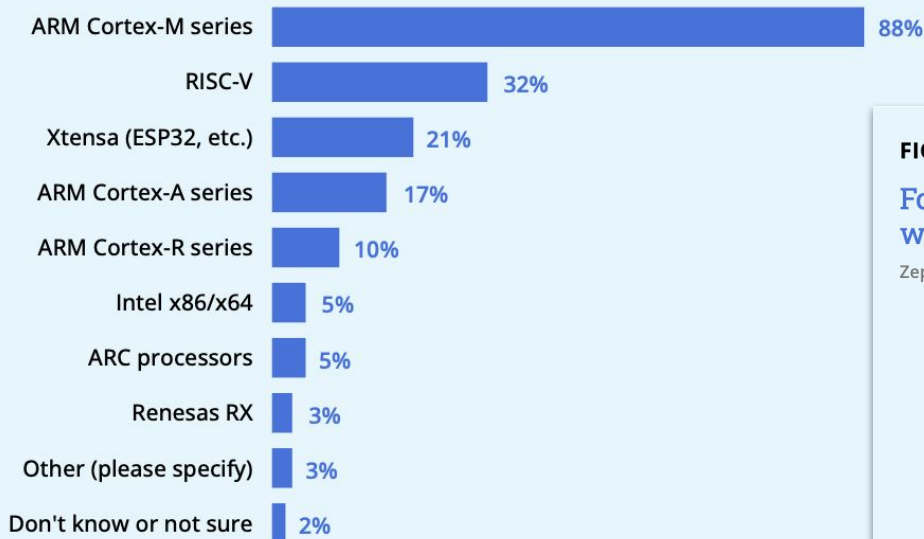
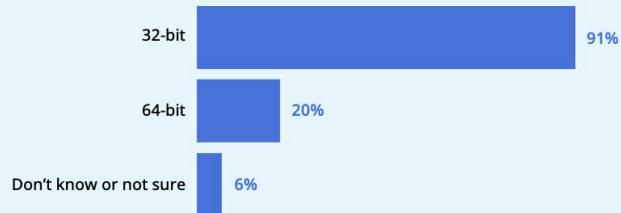


FIGURE 16

For the platforms you selected, which bit-widths does your organization use?

Zephyr Turns 10 Survey, Q29, Sample Size = 230, Total Mentions = 271

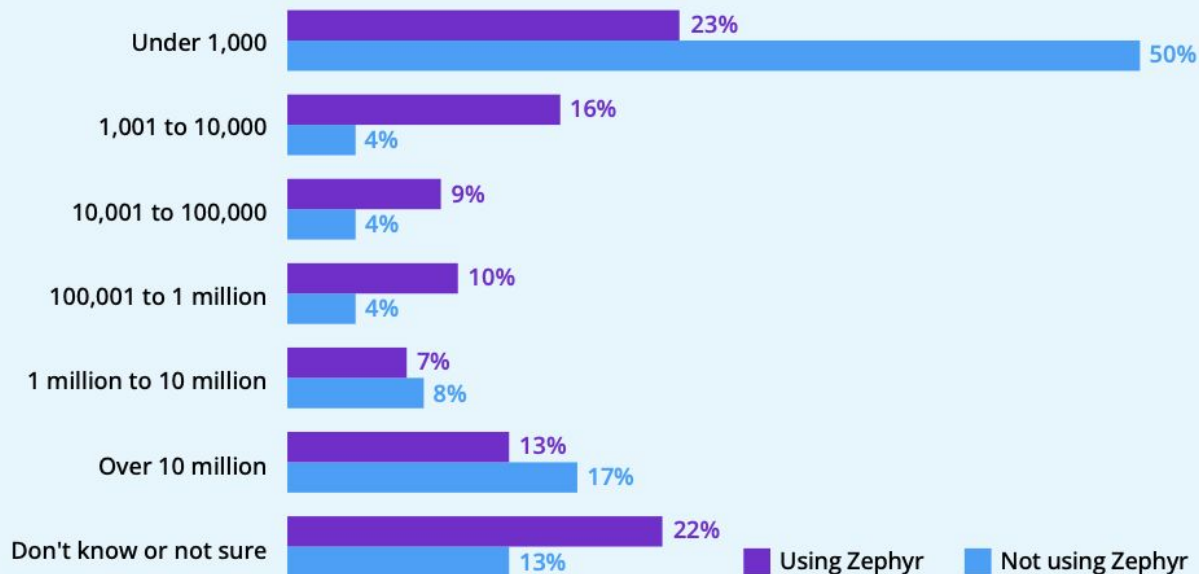


How Many Deployed Devices with RTOS(es)?

FIGURE 6

Approximately
how many
hardware
devices has your
organization
deployed using
RTOS(es)?

Zephyr Turns 10 Survey, Q10/
Q16, Sample Size = 365, Using
= Current Zephyr users or
planning to use Zephyr, Not
using = Past Zephyr users or
not planning to use Zephyr



“Before moving to Zephyr, our wireless keyboards delivered around 200 hours of battery life at a 1k polling rate. With Zephyr-based firmware, using the same battery size, we now achieve more than 600 hours at an 8k polling rate. That is a fundamental improvement in power efficiency and performance at the same time.”

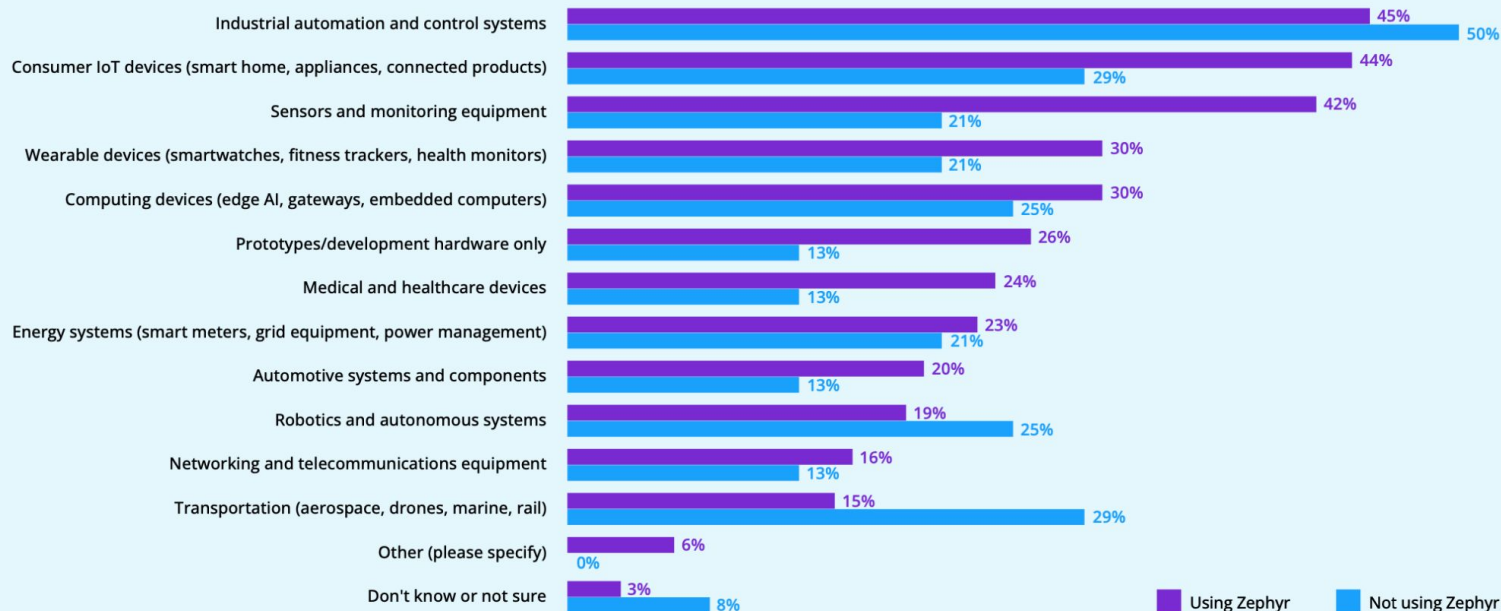
— PAUL TAN, COO, KEYCHRON

RTOS usage per Market Segments

FIGURE 7

In which types of hardware does your organization use RTOS?

Zephyr Turns 10 Survey, Sample Size = 375, Total Mentions = 1,267, Using = Current Zephyr users or planning to use Zephyr, Not using = Past Zephyr users or not planning to use Zephyr



Using Zephyr

Not using Zephyr

“What immediately stood out with Zephyr was the engineering quality. The codebase felt clean, familiar, and practical for real-time control, especially coming from a Linux background. It takes best practices from other open source projects and applies them in a way that makes the system predictable, extensible, and developer-friendly.”

— YASUSHI SHOJI, CO-FOUNDER AND CEO, SPACE CUBICS

ZEPHYR® TURNS 10



69% of organizations plan to increase or significantly increase their use of Zephyr, while only 1% expect to decrease usage.

Future Adoption Plans

FIGURE 17

What are your organization's future plans for Zephyr?

Zephyr Turns 10 Survey, Q30, Sample Size = 230

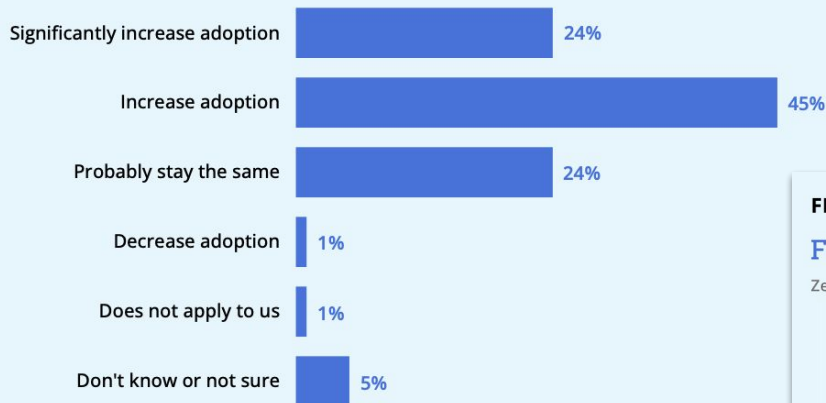
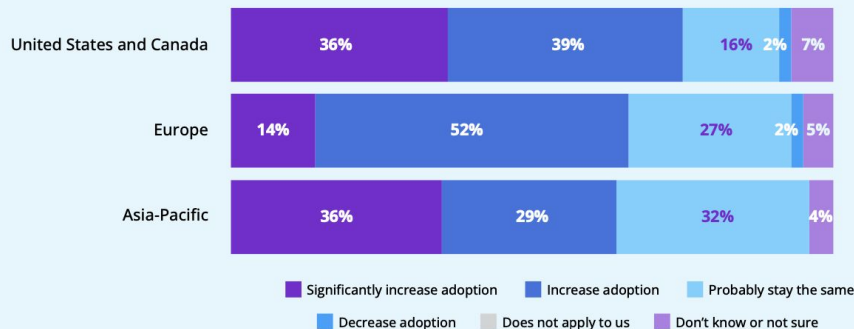


FIGURE 18

Future adoption plans for Zephyr by region

Zephyr Turns 10 Survey, Q30/Q6, Sample Size = 215



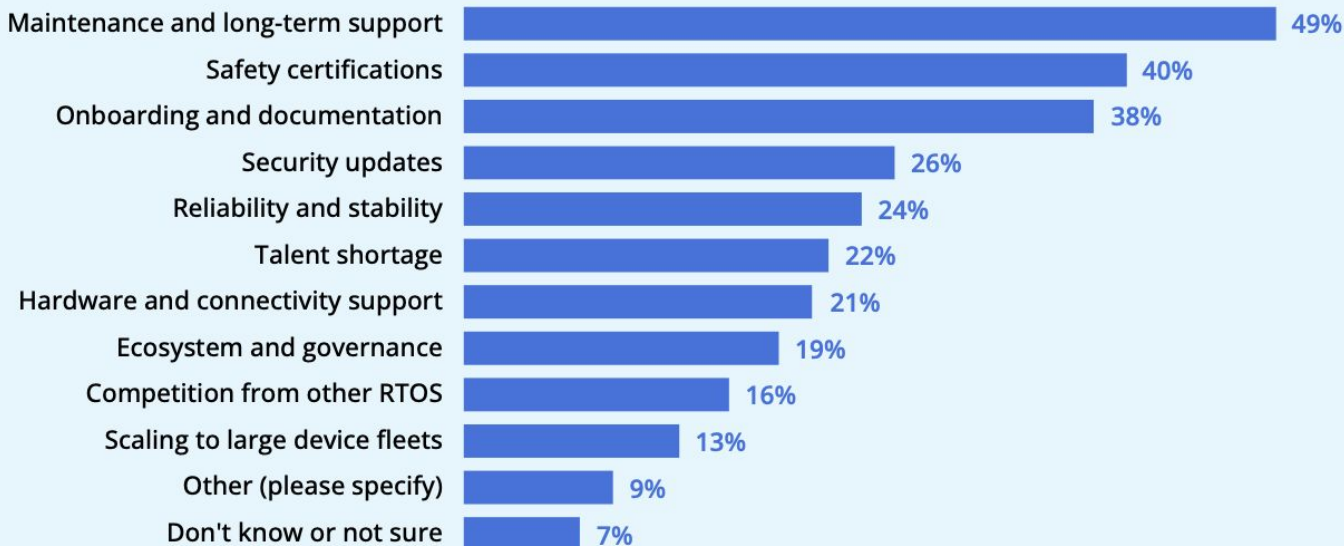
What is the Zephyr project
focusing on now?

Challenges on the Horizon?

FIGURE 23

What are the biggest challenges facing Zephyr in the next five years?

Zephyr Turns 10 Survey, Q39, Sample Size = 215, Total Mentions = 610

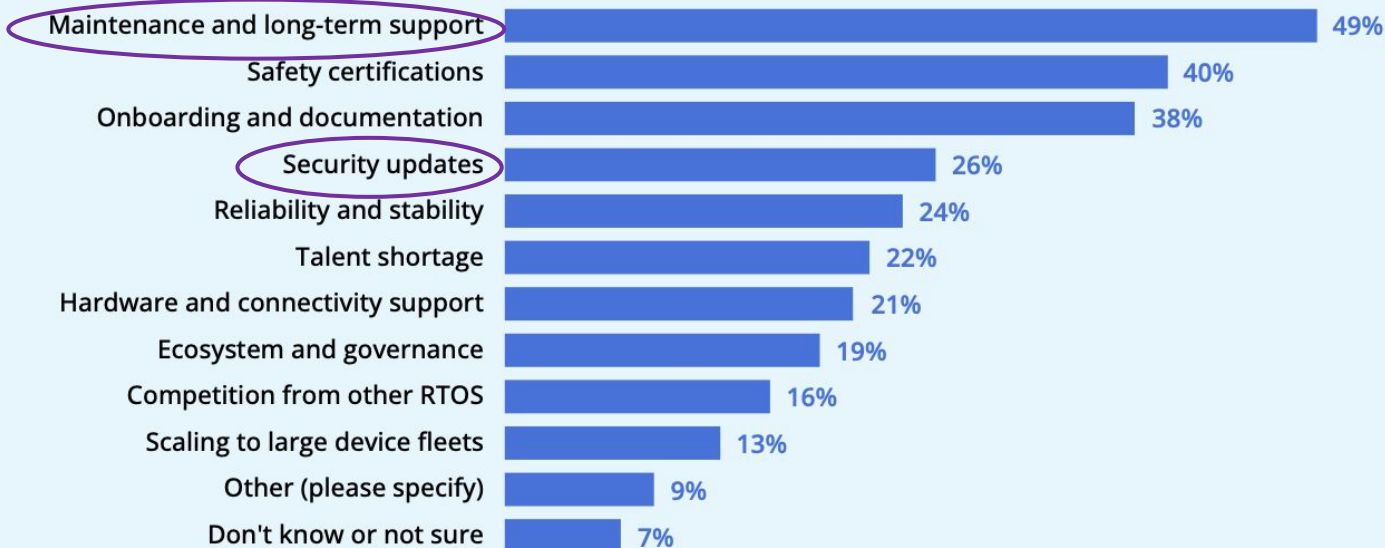


Challenges on the Horizon?

FIGURE 23

What are the biggest challenges facing Zephyr in the next five years?

Zephyr Turns 10 Survey, Q39, Sample Size = 215, Total Mentions = 610

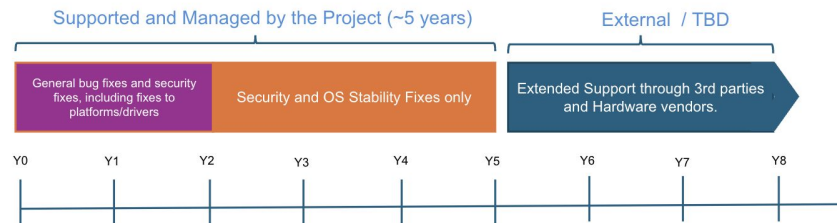


Process Evolution to help Manufacturers

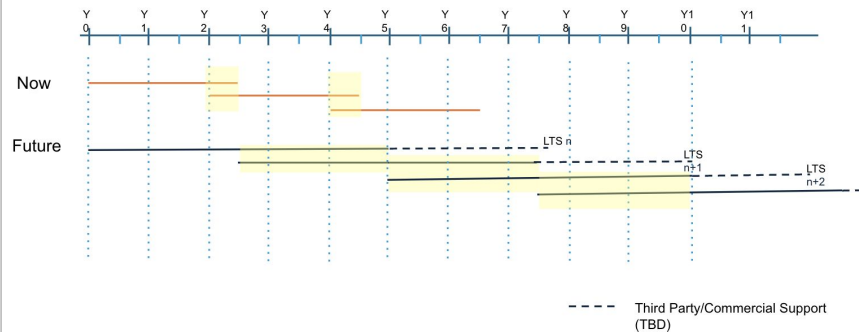


TSC approved extensions to Long Term Support (LTS) support from 2.5 to **5 years** from the project on March 8, 2025.

LTS Support Phases



LTS Release Lifecycle / Lifetime



Source: Anas Nashif, Zephyr TSC Chair, Zephyr TSC Meeting

CRA Aligns with Focus on Security & LTS



Source: www.linuxfoundation.org/research/cra-compliance-best-practices

Zephyr CRA Steward Readiness



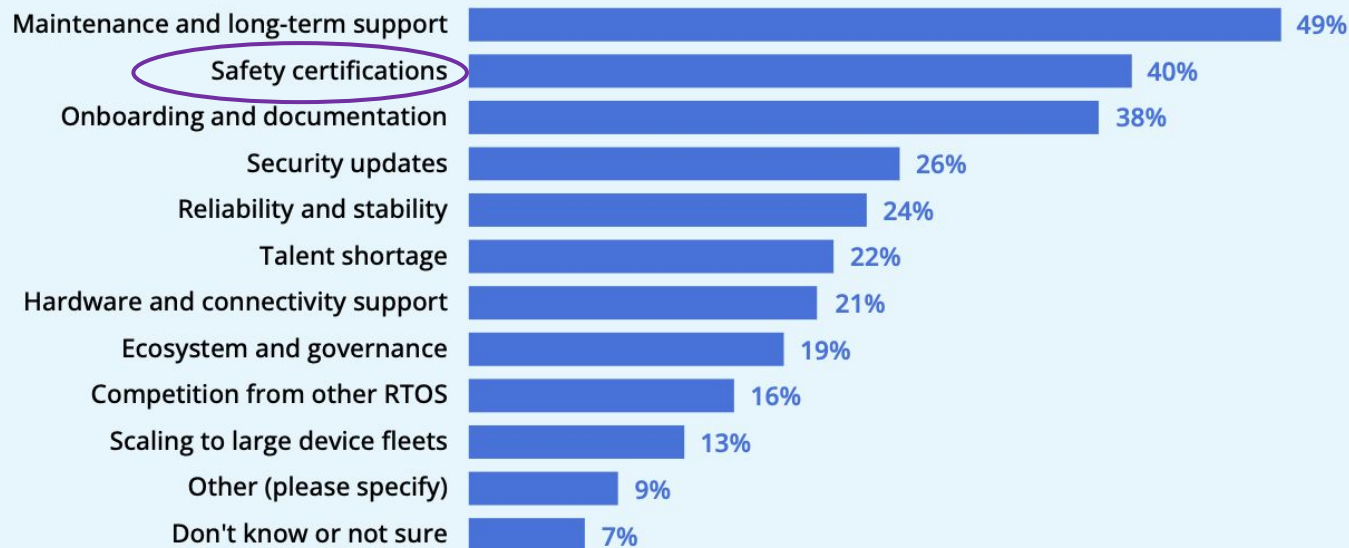
Article	Summary	Zephyr Status
Article 24.1	Security policy & vulnerability reporting process / link	✓ Documented in Project (policy & vulnerability reporting process).
Article 24.2	Cooperate with MSAs to reduce risk	✓ Working already with CVE Authorities as CNA .
Article 14.1	CSIRT Contact established	✓ Identify CSIRT coordinator for EU
Article 14.3	Notify CSIRT & ENISA of "severe" vulnerabilities	🕒 Determine if processes used with NVD will work or if adjustments required.
Article 14.8	Notify end-consumers of "severe" vulnerabilities	✓ Provide information to manufacturers & integrators signed up on Zephyr Vulnerability Alert Registry
Article 52.3	Stewards found non-compliant must take corrective actions to respect obligations	✓ Doing this today with CVE authorities

Challenges on the Horizon?

FIGURE 23

What are the biggest challenges facing Zephyr in the next five years?

Zephyr Turns 10 Survey, Q39, Sample Size = 215, Total Mentions = 610



Safety Compliance: V-model Standards

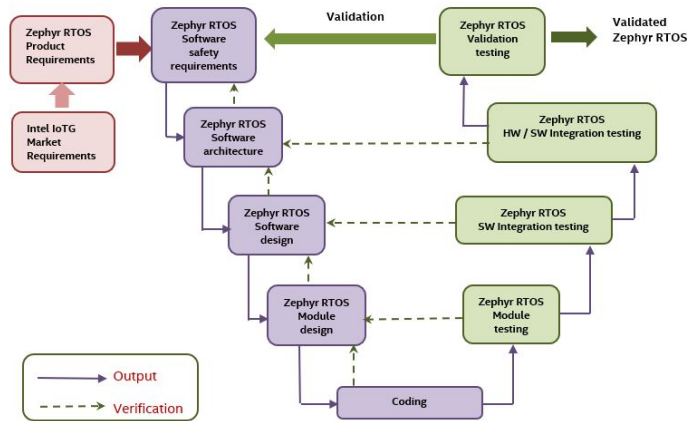


It is difficult to map a stereotypical open-source development to the V-model

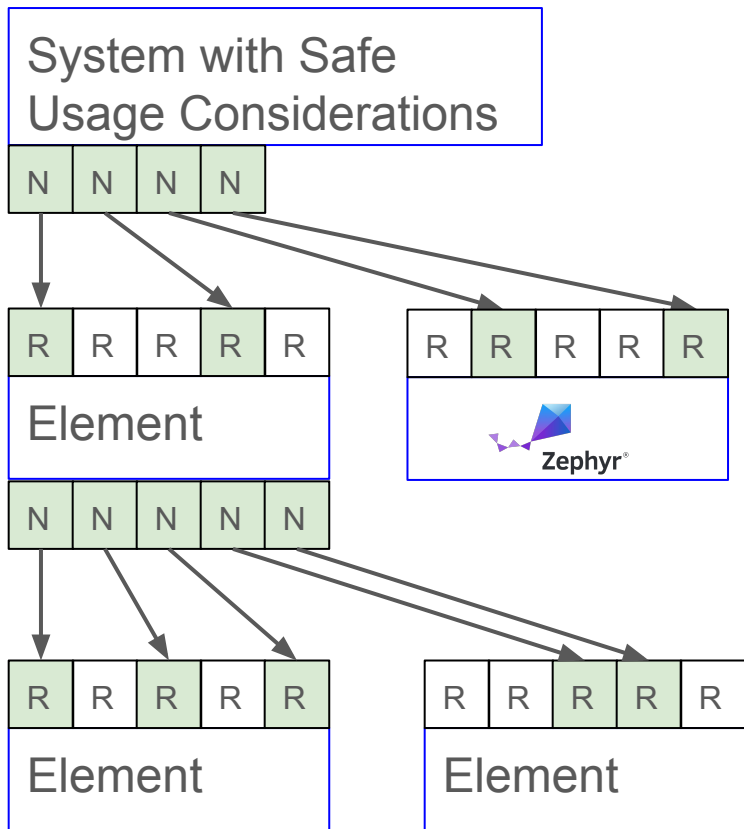
- Specification of features
- Comprehensive documentation
- Traceability from requirements to source code
- Number of committers and information known about them

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

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



Safety Element out of Context - SEooC



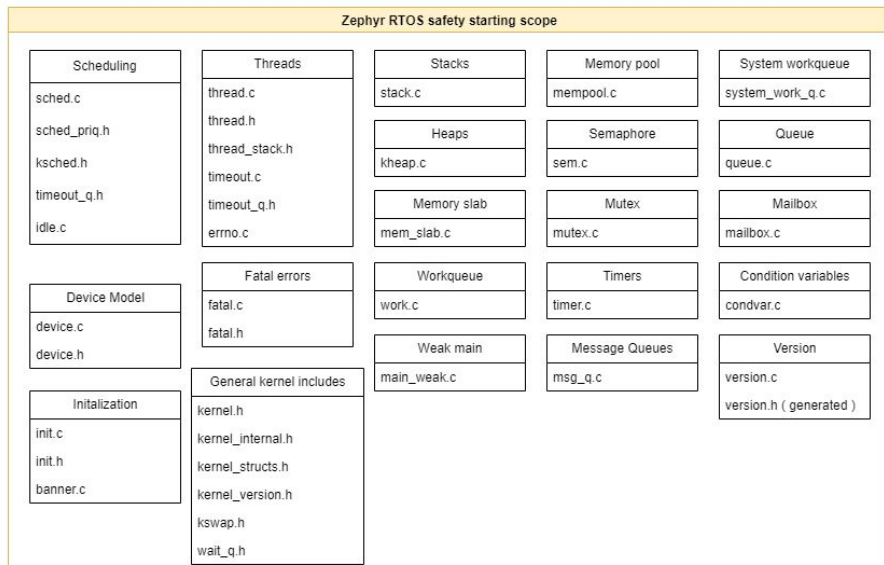
Development and verification independent of a specific context or application

Provides integration and operation information for safe system integration

Comes with sufficient evidence, that it can be integrated to a safety relevant system.

Initial Safety 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 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 Assessment & Certification Plan



Phase 1 - Concept Phase

Approval of the overall plans and strategy, scope and high level requirements & architecture

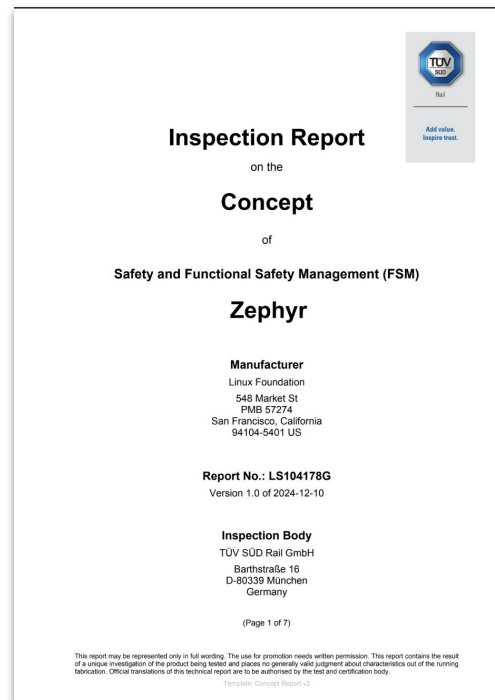
Phase 2 - Detailed Phase

Filling the gaps:

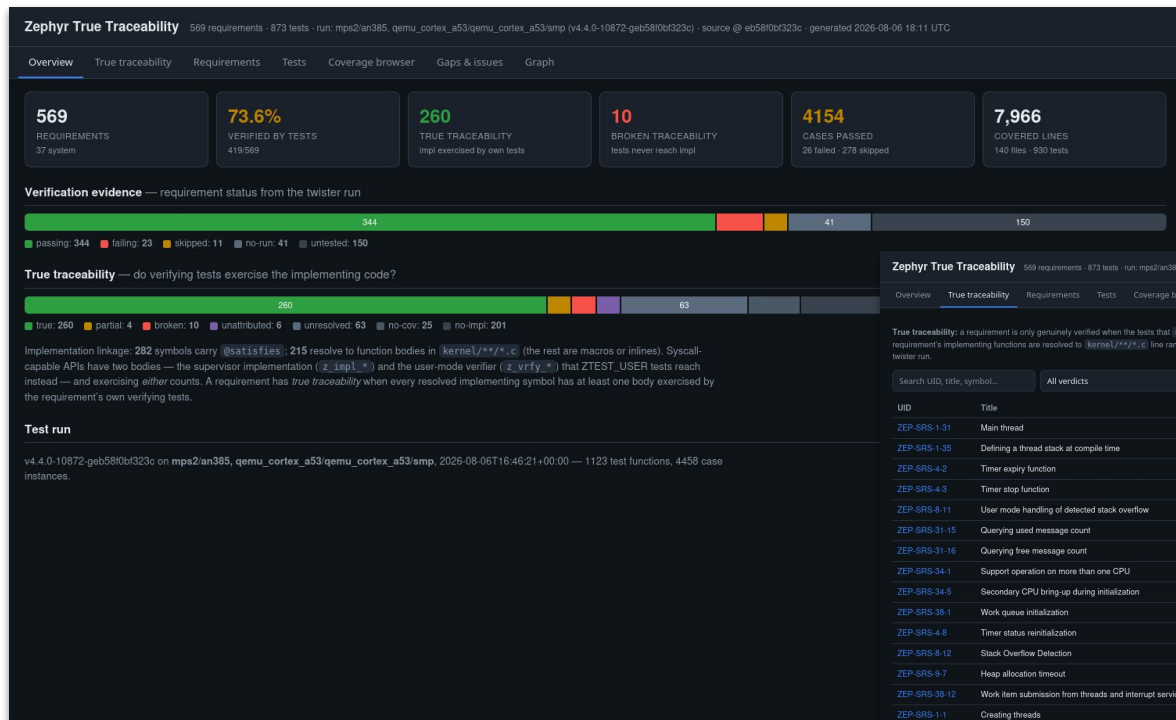
- Completeness of requirements
- Safety Analysis
- Traceability
- Verification & Test Coverage

Status in 2025

- Coding Guidelines established based on MISRA rules and applied
- Static Analysis tooling to check for adherence to Guidelines selected for future contributions
- Reference Requirements and Traceability started in the code base
- Automatic human readable documentation of requirements from StrictDoc rules is available
- **Formal concept approval for Phase 1 is complete ... on to Phase 2**



Phase 2: Progress to date



Zephyr True Traceability 569 requirements · 873 tests · run: mps2/an385, qemu_cortex_a53/qemu_cortex_a53/smp (v4.4.0-10872-geb5810bf323c) · source @ eb5810bf323c · generated 2026-08-06 18:11 UTC

Overview True traceability Requirements Tests Coverage browser Gaps & issues Graph

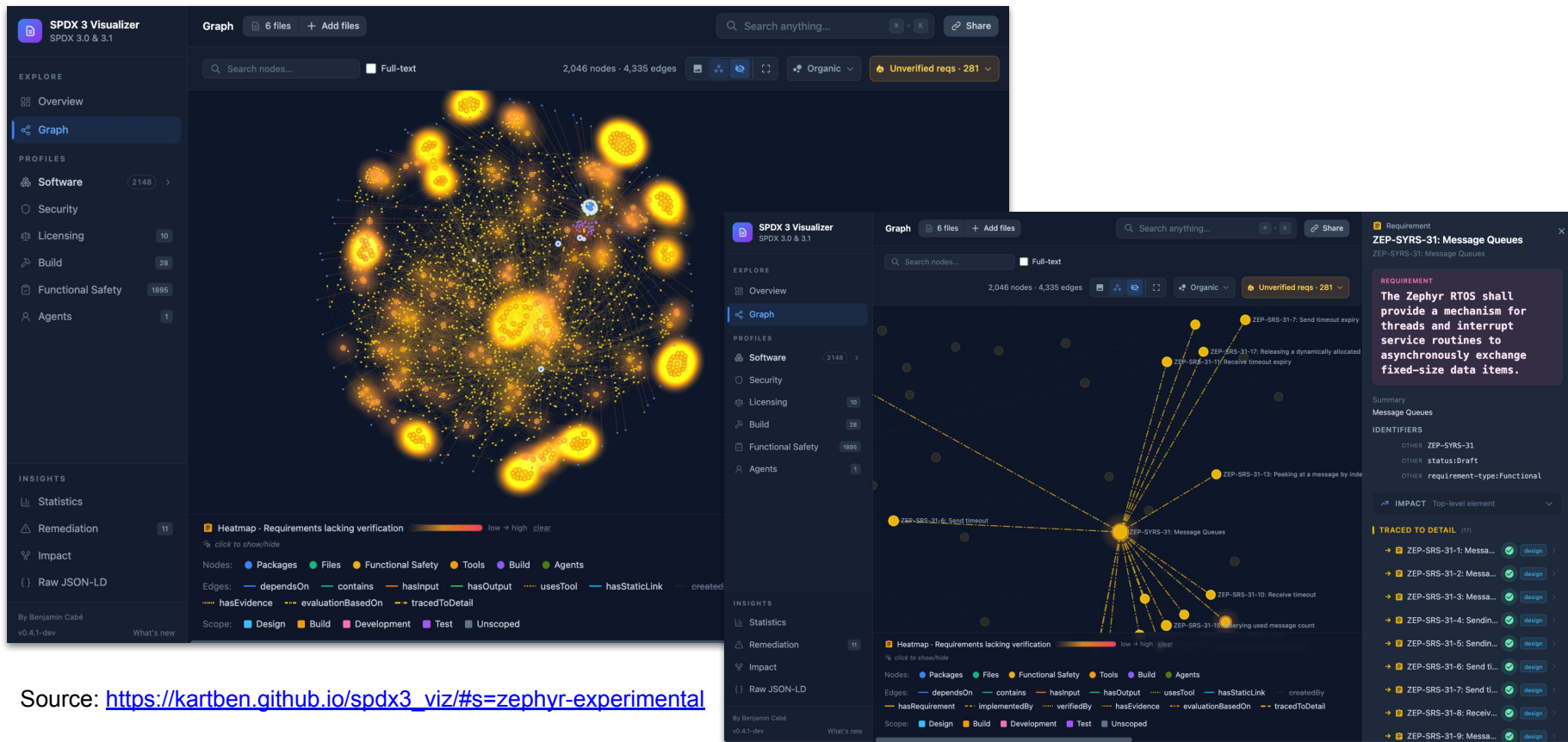
True traceability: a requirement is only genuinely verified when the tests that @verifies it actually execute the code that @satisfies it. Below, each requirement's implementing functions are resolved to kernel/**/*.c line ranges and intersected with the line coverage of its verifying tests from this twister run.

Search UID, title, symbol... All verdicts 368 requirements

UID	Title	Component	Evidence	Impl fns	Exercised by own tests	Verdict
ZEP-SRS-1-31	Main thread	Threads	passing	1	0/1	broken
ZEP-SRS-1-35	Defining a thread stack at compile time	Threads	passing	2 (1 unresolved)	0/1	broken
ZEP-SRS-4-2	Timer expiry function	Timers	passing	2 (1 unresolved)	0/1	broken
ZEP-SRS-4-3	Timer stop function	Timers	passing	2 (1 unresolved)	0/1	broken
ZEP-SRS-8-11	User mode handling of detected stack overflow	Memory Protection	passing	1	0/1	broken
ZEP-SRS-31-15	Querying used message count	Message Queues	passing	1	0/1	broken
ZEP-SRS-31-16	Querying free message count	Message Queues	passing	1	0/1	broken
ZEP-SRS-34-1	Support operation on more than one CPU	Multi Core	passing	1	0/1	broken
ZEP-SRS-34-5	Secondary CPU bring-up during initialization	Multi Core	passing	1	0/1	broken
ZEP-SRS-38-1	Work queue initialization	Work Queues	passing	1	0/1	broken
ZEP-SRS-4-8	Timer status reinitialization	Timers	passing	4	2/4	partial
ZEP-SRS-8-12	Stack Overflow Detection	Memory Protection	passing	2	1/2	partial
ZEP-SRS-9-7	Heap allocation timeout	Memory Objects	passing	2	1/2	partial
ZEP-SRS-38-12	Work item submission from threads and interrupt service routines	Work Queues	passing	2	1/2	partial
ZEP-SRS-1-1	Creating threads	Threads	passing	1	1/1	true
ZEP-SRS-1-2	Setting thread priority	Threads	passing	1	1/1	true
ZEP-SRS-1-3	Suspending a thread	Threads	passing	1	1/1	true
ZEP-SRS-1-4	Resuming a suspended thread	Threads	passing	1	1/1	true
ZEP-SRS-1-5	Delayed thread start	Threads	passing	1	1/1	true
ZEP-SRS-1-6	Aborting a thread	Threads	passing	1	1/1	true
ZEP-SRS-1-8	Thread stack objects	Threads	passing	2 (1 unresolved)	1/1	true

Source: Anas Nashif, Zephyr TSC Chair,
with assistance from Claude

Phase 2: Progress to Date



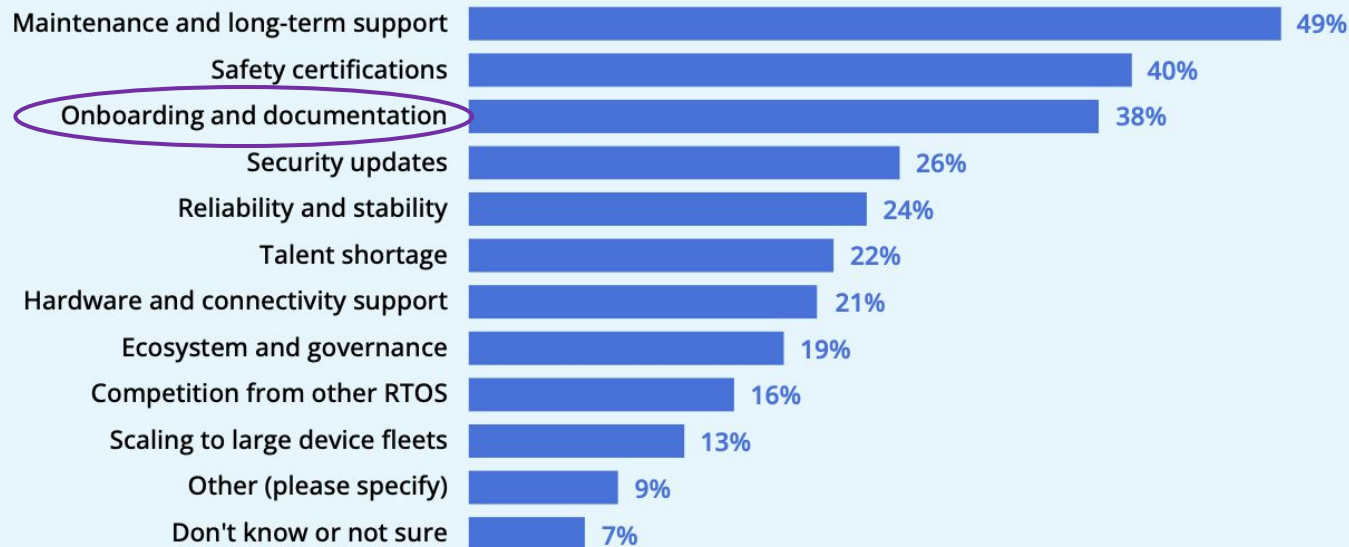
Source: https://kartben.github.io/spdx3_viz/#s=zephyr-experimental

Challenges on the Horizon?

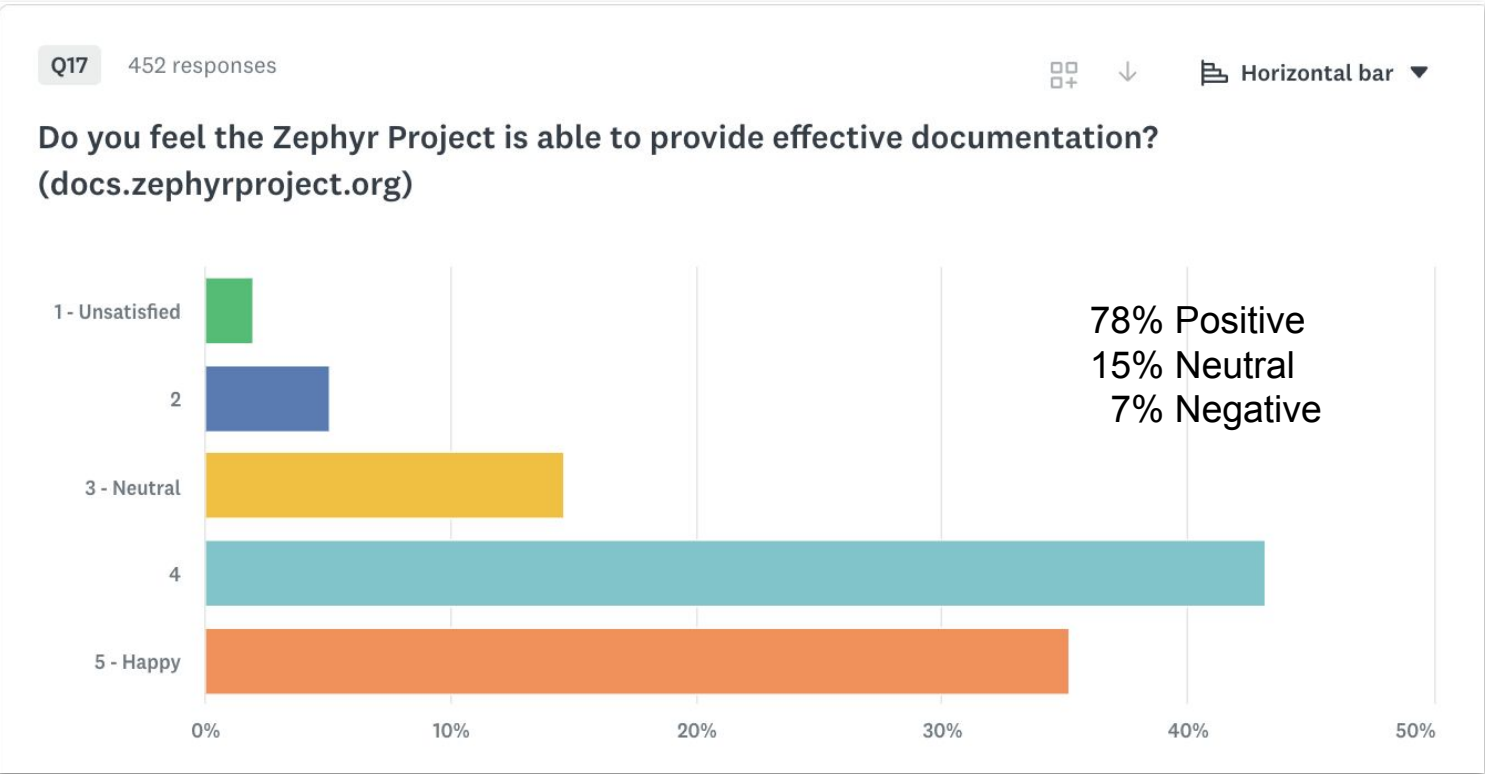
FIGURE 23

What are the biggest challenges facing Zephyr in the next five years?

Zephyr Turns 10 Survey, Q39, Sample Size = 215, Total Mentions = 610



2026: Do you feel the Zephyr Project is able to provide effective documentation?



2025
73% Positive
13% Neutral
14% Negative

2024
70% Positive
16% Neutral
14% Negative

2023
63% Positive
17% Neutral
20% Negative

“Ten years in, Zephyr has passed the hardest test for any open source project: survival and sustained adoption. Many projects appear, gain attention, and disappear. Zephyr is now an established platform with real production impact across industries.”

— ANAS NASHIF, SENIOR PRINCIPAL ENGINEER, INTEL; ZEPHYR MAINTAINER, TSC CHAIR, AND BOARD MEMBER

Thank you to the Zephyr community of developers for the excellent technical work you've contributed to the project over the last 10 years!



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