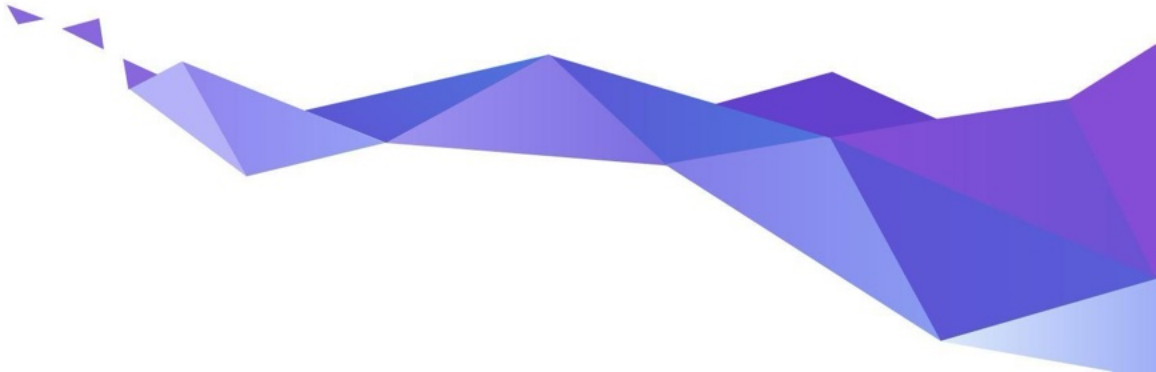
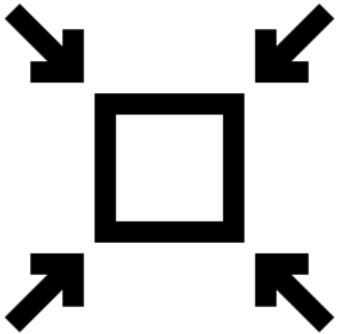
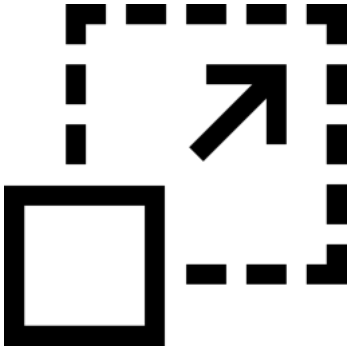
Zephyr Project Overview

A proven RTOS ecosystem, by developers, for developers



Use cases for a real-time OS





SMALL *yet* SCALABLE

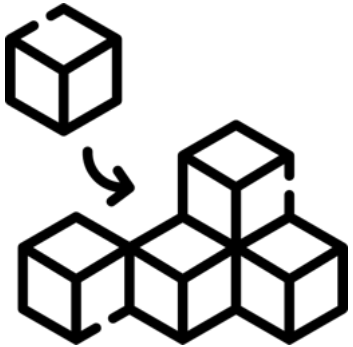
< 8KB Flash

< 5KB RAM

from small sensor nodes

... to complex multi-core systems

Zephyr®



FLEXIBLE *yet* SECURE

Heavily customizable

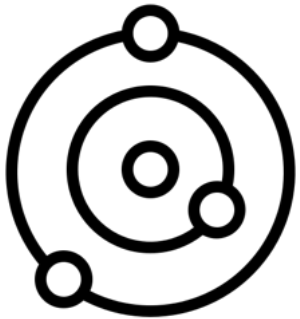
Out-of-the-box support for
600+ boards and 100s of sensors

Built with safety & security in mind

Certification-ready

Long-term Support

Zephyr®



OPEN-SOURCE

Permissively licensed (Apache 2.0)

Vendor-neutral governance

ECOSYSTEM

Vibrant community

Supported by major silicon vendors

Features overview

- **Lightweight kernel & supporting drivers and services**
- **Portable, secure, power-efficient**
- **Highly connected**
  - Bluetooth 5.0 & BLE
  - Wi-Fi, Ethernet, CANbus, ...
  - IoT protocols: CoAP, LwM2M, MQTT, OpenThread, ...
  - USB & USB-C

- **Complete developer environment**
  - Toolchain and HAL management
  - Logging, tracing, debugging,
  - Emulation/Simulation
  - Testing framework

Products Running Zephyr Today

Oticon 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

Products Running Zephyr Today

Discreet rechargeable hearing aid that gives you access to all relevant sounds

Oticon More supports the brain in making sense of sound and it is easy to operate with a double push button for volume and programme control. It features Bluetooth wireless technology for seamless connectivity with your favourite devices.

oticon
life-changing **technology**

Bluetooth LE

Low Power

zephyrproject.org/portfolio/oticon-more

Products Running Zephyr Today

Sustainable energy solutions

Vestas is the energy industry's global partner on sustainable energy solutions. We design, manufacture, install, and service onshore and offshore wind turbines across the globe, and with more than 164 GW of wind turbines in 87 countries, we have installed more wind power than anyone else. Through our industry-leading smart data capabilities and unparalleled more than 144 GW of wind turbines under service, we use data to interpret, forecast, and exploit wind resources and deliver best-in-class wind power solutions. Together with our customers, Vestas' more than 28,000 employees are bringing the world sustainable energy solutions to power a bright future.

Vestas®

CANbus

Industrial Control

zephyrproject.org/portfolio/vestas-wind-turbines

Products Running Zephyr Today

Thin, light, high-performance 13.5" notebook

A thin, light, high-performance 13.5″ notebook that is also easy to repair, upgrade, and customize. The embedded controller firmware is a fork of the Zephyr version of chromium-ec, and is fully open source.

framework

Embedded Controller

USB / USB-C

Power Mgmt

zephyrproject.org/portfolio/framework-laptop-13-diy-edition-amd-ryzen-7040-series

Products Running Zephyr Today

Professional grade, digital tape measure

The T1 Tomahawk, the world's first, professional grade, digital tape measure enables tradespeople, across industries, to collect measurements faster and more accurately than ever before. A live view, OLED display, shows measurements of the tape measure, digitally, in both english and metric units. With a click of a button, measurements are saved to a side mounted e-paper display as well as sent over Bluetooth to connected devices.

REEKON

Low Power

Sensing

zephyrproject.org/portfolio/reekon-t1-tomahawk

Products Running Zephyr Today

Turns your wired sensors into IP67-rated battery-operated wireless nodes, providing robust and secure messaging

Ezurio's **Sentrius™ BT610** I/O Sensor with Bluetooth 5 turns your wired sensors into IP67-rated battery-operated wireless nodes, providing robust and secure messaging. Leveraging our BL654 module, it provides full Bluetooth 5 capabilities, opening up industrial and equipment monitoring applications.

ezurio

Bluetooth

Cellular

Connectivity Management

App Framework

zephyrproject.org/portfolio/sentrius

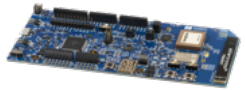
750+ supported boards... and growing

Zephyr®

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/

220+ Sensors Already Integrated

adt7420
adxl345
adxl362
adxl372
ak8975
amg88xx
ams_as5600
ams_iAQcore
apds9960
bma280
bmc150_magn
bme280
bme680
bmg160
bmi160
bmi270
bmm150
bmp388
bq274xx
ccs811

dht
dps310
ds1[illegible]
ens[illegible]
esp[illegible]
fdc[illegible]
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fxo[illegible]
grove
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hmc5883l
hp206c
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iis2dlpc

iis2iclx
iis2mdc
iis3dhhc
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lps22hh
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lsm9ds0_mfd
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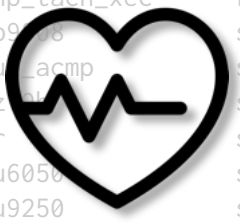
max30101
max31875
max44009
max6675
mchp_tach_xec
mcp9[illegible]
mcu_[illegible]acmp
mhz[illegible]
mpr
mpu6050
mpu9250
ms5607
ms5837



nrf5
nuvoton_adc_cmp_npcx
nuvoton_t[illegible]_npcx
nxp_kin[illegible]
opt300[illegible]
pcnt_es[illegible]
pms7003
qdec_mc[illegible]
qdec_nrfx
qdec_sam
qdec_stm32
rpi_pico_temp
sbs_gaug[illegible]
sgp40
sht3xd
sht4x
shtcx
si7006
si7055
si7060

si7210
sm351lt
stm32_temp
stm32_vbat
stmemsc
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

Supported Hardware Architectures

Zephyr®

ARC®

arm

Cortex-M, Cortex-R
& Cortex-A

intel®

x86 & x86_64

MIPS

Nios® II
Processor

RISC-V®

32 & 64 bit

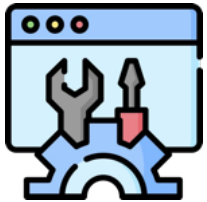
SPARC

tensilica

Xtensa

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

Vibrant Ecosystem



Development Tools

Governing Board

Technical Steering Committee

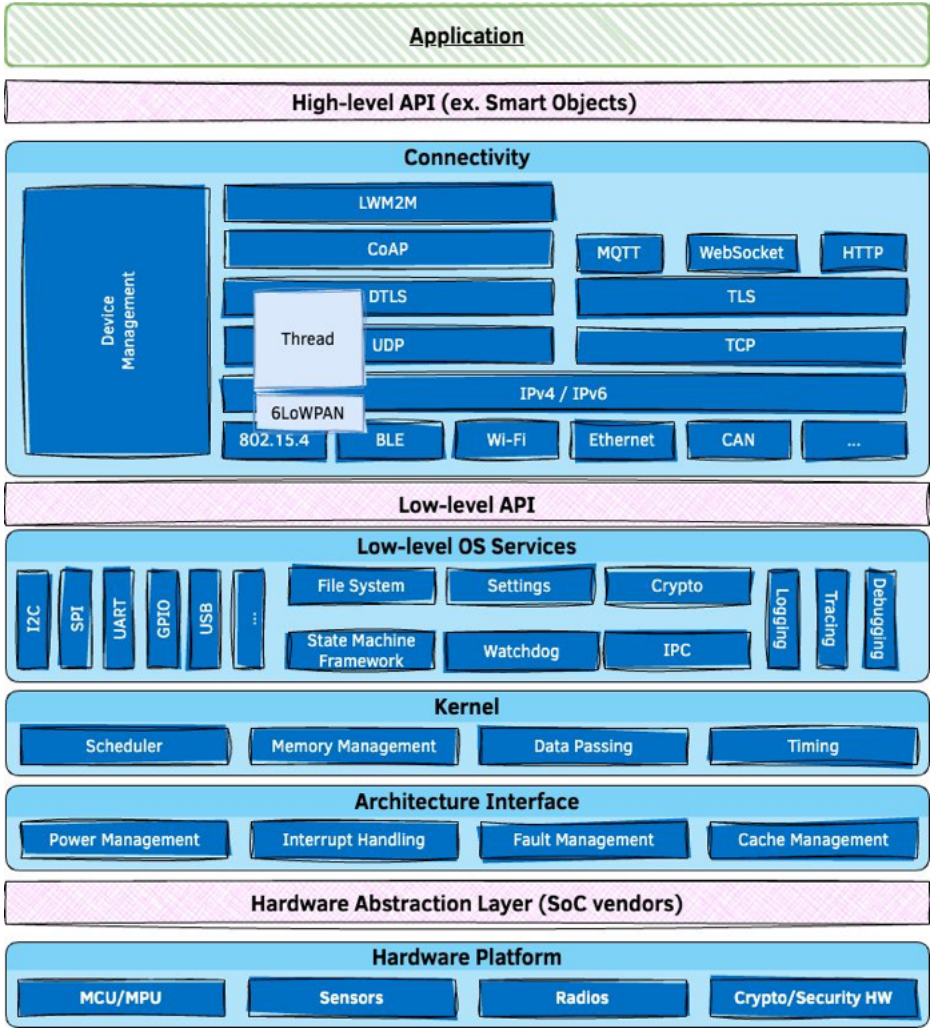
Contributors

Applications & Middlewares

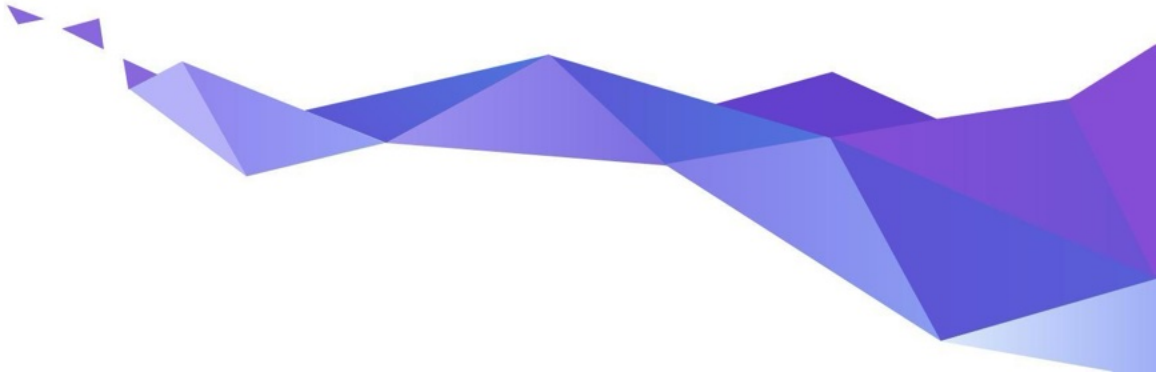
Training & Consulting

Firmwares & Libraries

Architecture



Diving into Zephyr’s features



Devicetree

Describe & **configure** the available hardware on the target system

Decouple the application from the hardware

\+ **Kconfig** for all things configuration

docs.zephyrproject.org/latest/build/dts

```
&i2c1 {
    pinctrl-0 = <&i2c1_scl_pb8 &i2c1_sda_pb9>;
    pinctrl-names = "default";
    clock-frequency = <I2C_BITRATE_FAST>;
    status = "okay";

    lsm6dsl@6a {
        compatible = "st,lsm6dsl";
        reg = <0x06a >;
    };

    hts221@5f {
        compatible = "st,hts221";
        reg = <0x5f >;
    };

    // …
};
```

`.dts` file example

West meta-tool

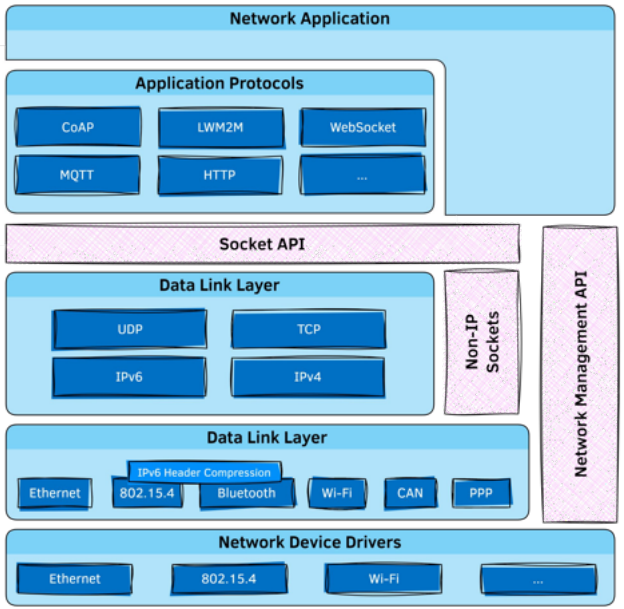
- **Module Management**
  - Simplifies Versioning and integration of various modules/libraries in the build system
- **Build**
- Extensible **command-line interface**
  - e.g. custom commands for specific board
  - Static code analysis, RAM/ROM reports

Connectivity Options

- Wide variety of **communication protocols**
  - Ethernet, 802.15.4, Thread, LoRa, Bluetooth, CAN bus, ...
- **Core network protocols** like IPv6, IPv4, UDP, TCP, ICMPv4, and ICMPv6.
- **Security** (ex. TLS, DTLS, ...)
- **Cloud integration** using MQTT, CoAP and HTTP protocols
- **Over-the-air updates**
- **Device management** using OMA LwM2M 1.1 protocol

Native IP Stack

- Built from scratch, on top of Zephyr native kernel concepts
- Dual mode **IPv4/IPv6 stack**
  - DHCP v4, IPv4 autoconf, IPv6 SLAAC, DNS, SNTP
- Multiple network interfaces support
- Time Sensitive Networking support
- **BSD Sockets**-based API
- Supports IP offloading
- **Compliance and security** tested



Zephyr®

Bluetooth 5.3 compliant •
LE Controller • Host • Mesh •
Bluetooth-SIG qualifiable

USB 2.0 • USB-C •
Device & Host • WebUSB

Power Management

- **Goal**: reduce power consumption while preserving responsiveness
- **Key concepts**
  - **Tickless kernel**
  - System PM: idle thread, interruptions only for registered events
  - Device PM: device drivers can react to PM state changes
- Handled by the kernel / Customizable by the user

Zephyr USB Device Stack

- **USB 2.0** & **USB-C** support
- Supports multiple MCU families (STM32, Kinetis, nRF, SAM,...)
- Supports most common devices classes: CDC, Mass Storage, HID, Bluetooth HCI over USB, DFU, USB Audio, etc.
- Tight integration with the RTOS
- Native execution support for emulated development on Linux
- WebUSB support

Devicetree

Describe & **configure** the available hardware on the target system

Decouple the application from the hardware

```
&i2c1 {
    pinctrl-0 = <&i2c1_scl_pb8 &i2c1_sda_pb9>;
    pinctrl-names = "default";
    clock-frequency = <I2C_BITRATE_FAST>;
    status = "okay";

    lsm6dsl@6a {
        compatible = "st,lsm6dsl";
        reg = <0x06a >;
    };

    hts221@5f {
        compatible = "st,hts221";
        reg = <0x5f >;
    };

    // …
};
```

.dts file example

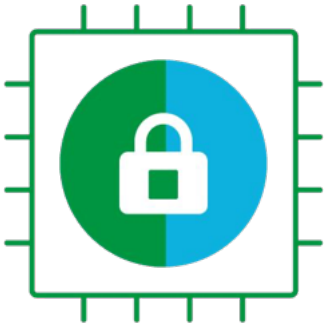
docs.zephyrproject.org/latest/build/dts

Secure boot / Device Management

- Leverage **MCUboot** as secure bootloader
- Application binary can be signed/encrypted
  - Can use hardware keys
- But also:
  - Downgrade prevention
  - Dependency checks
  - Reset and failure recovery
- Over-the-air (OTA) upgrades
  - OMA LwM2M, Eclipse hawkBit
  - Vendor offerings

Hardware security

- **Cryptography APIs**
  - Random Number Generation, ciphering, etc.
  - Supported by crypto HW, or SW implementation (TinyCrypt)
- **Trusted Firmware** integration
  - Firmware verification/encryption
  - Device attestation
  - Management of device secrets



Building on POSIX

- **Zephyr apps can run as native Linux applications**
  - Easier to debug/profile with native tools
  - Connect to real devices using TCP/IP, Bluetooth, CAN
  - Helps minimize hardware dependencies during the development phase
- **Re-use existing code & libraries by accessing Zephyr services through POSIX API**
  - Easier for non-embedded programmers
  - Implementation is optimized for constrained systems
  - Supported POSIX subsets: PSE51, PSE52, and BSD sockets

docs.zephyrproject.org/latest/guides/portability/posix.html

A real-time OS

Benchmark on Arm Cortex-M4F running at 120 MHz

Operation	Time
Thread create	2.5 µs
Thread start	3.6 µs
Thread suspend	3.3 µs
Thread resume	3.8 µs
Context switch (yield)	2.2 µs
Get semaphore	0.6 µs
Put semaphore	1.1 µs

github.com/zephyrproject-rtos/zephyr/tree/main/tests/benchmarks

Graphical User Interfaces

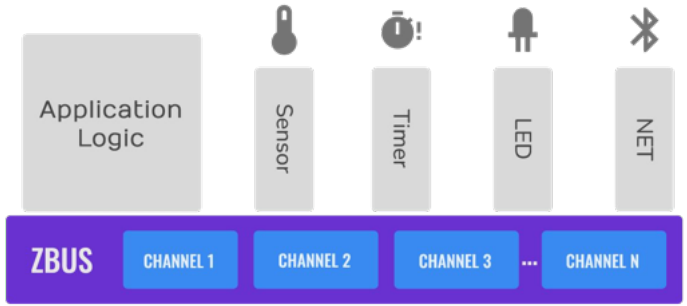
- Drivers available for various types of displays
  - LCD
  - OLED
  - Touch panel displays
  - E-ink
- LVGL integration
- Support for video capture and output

Inter-Process Communication

- **Built-in kernel services** (see table)
- **IPC service**
  - 1-to-1 or 1-to-many communications
  - No-copy API
- **zbus** (Zephyr Message Bus)
  - 1-to-1, 1-to-many, or many-to-many channel-based communications
  - Synchronous or asynchronous

Object	Bidirectional?	Data structure
FIFO	✘	Queue
LIFO	✘	Queue
Stack	✘	Array
Message queue	✘	Ring buffer
Mailbox	✔	Queue
Pipe	✘	Ring buffer

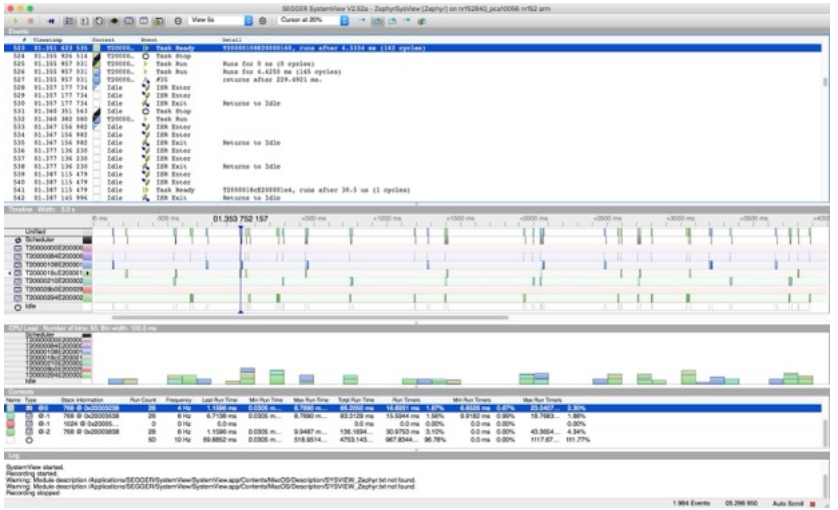
Data passing objects available in Zephyr kernel



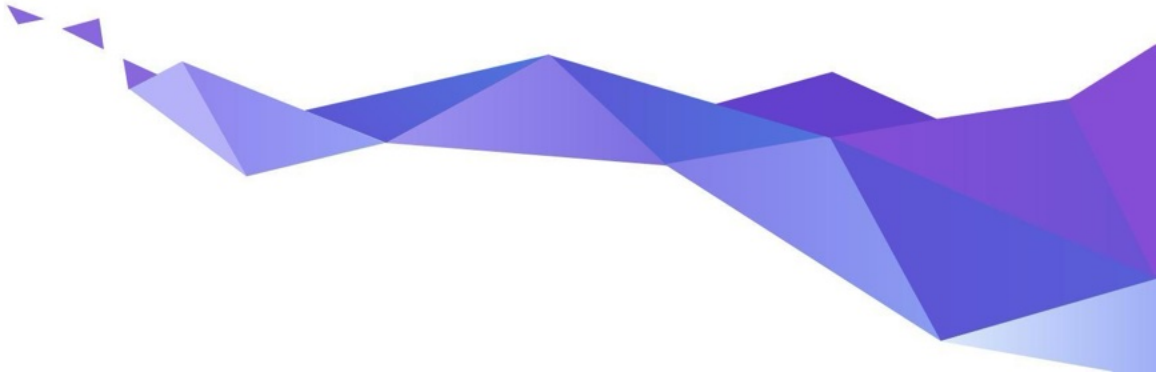
A typical zbus application architecture

Tracing & Debugging

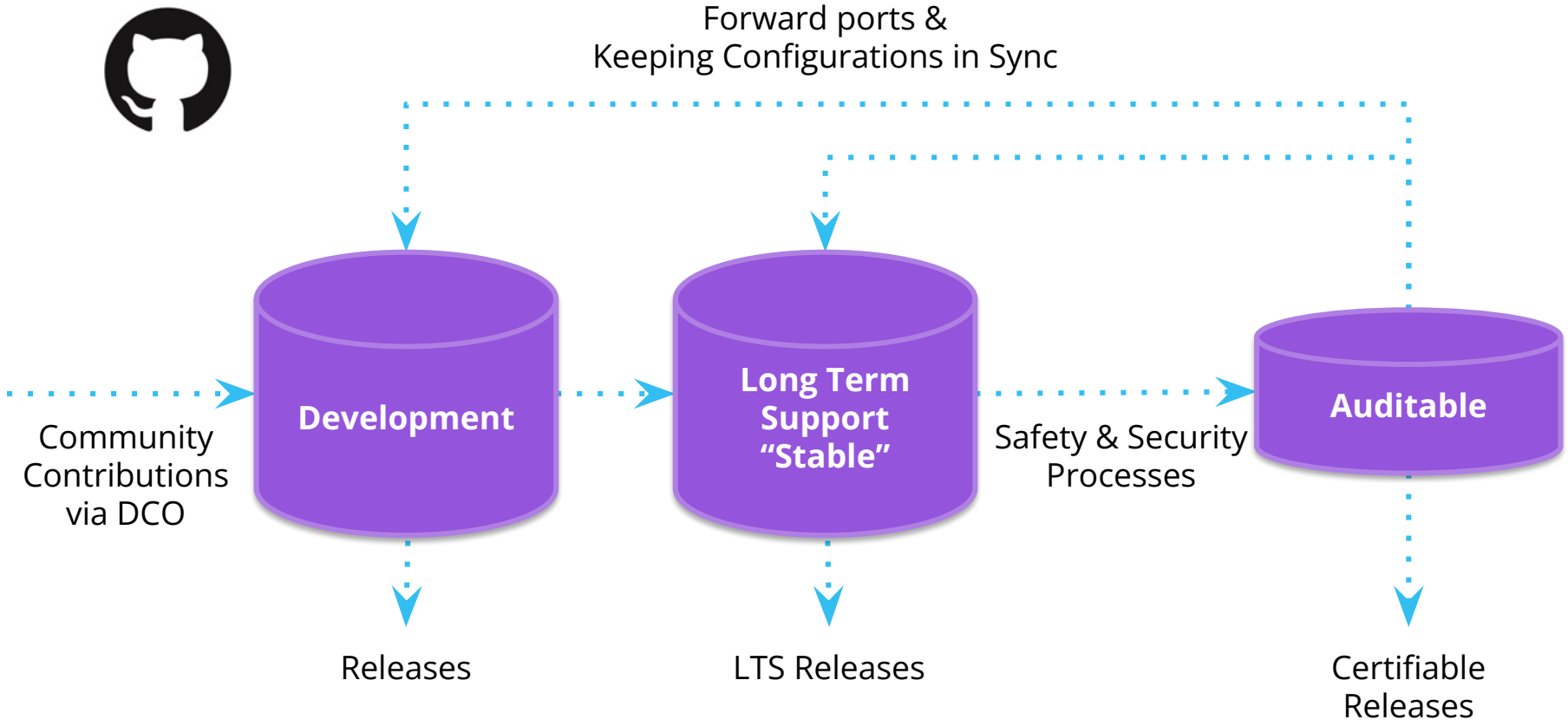
- Advanced **logging** framework
  - Multiple backends (UART, network, file system, ...)
  - Compile-time & runtime filtering
- **Tracing** framework
  - Visualize the inner-working of the kernel and its various subsystems
  - Object tracking (mutexes, timers, etc.)



Safety & Security



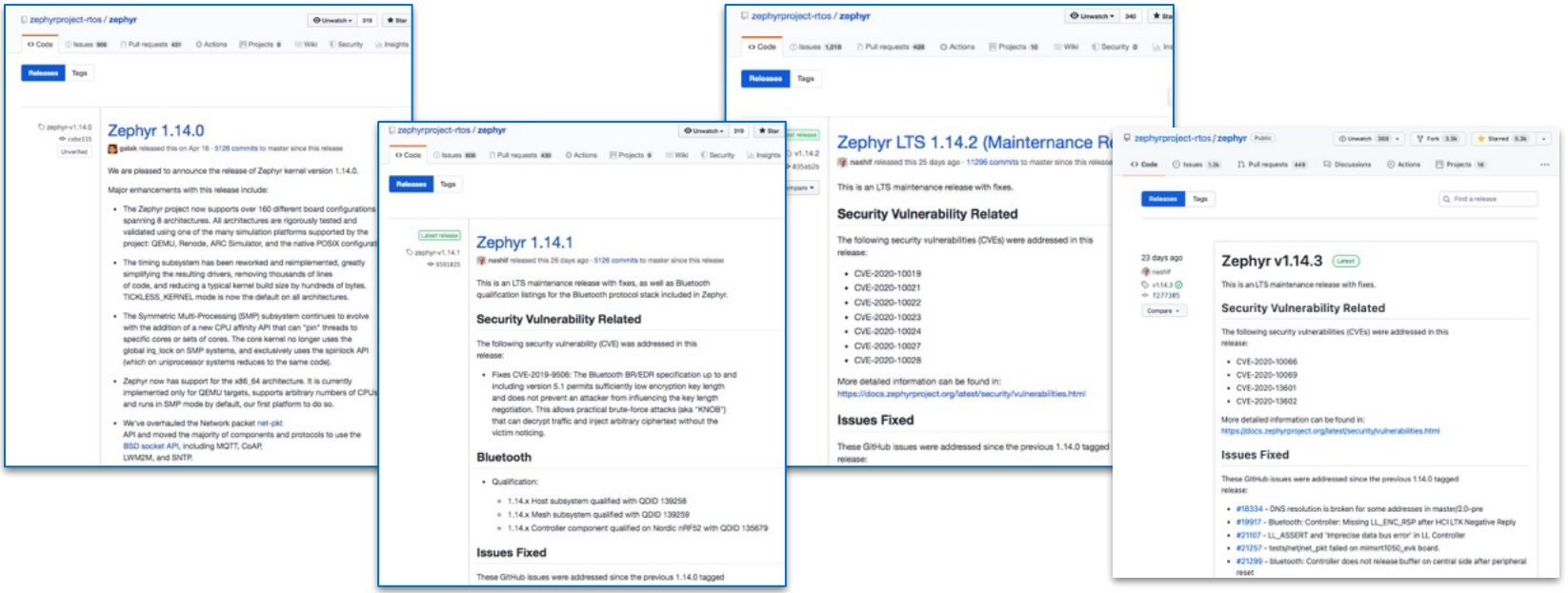
Code Repositories



Long Term Support (Zephyr 2.7.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**

Long Term Support (LTS - 1.14)



Delivered bug fixes and latest security updates for 2 years!

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

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

Software Supply Chain

- Zephyr ships an **SBOM** (Software Bill of Materials) with each release
- Downstream consumers can leverage built-in tools to, in turn, generate source & build SBOMs for their deliverables

```
[...]
FileName: ./zephyr/zephyr.elf
SPDXID: SPDXRef-File-zephyr.elf
FileChecksum: SHA1: e74cebcac51dabd799957ac51e4edcd32541103d
[...]
Relationship: SPDXRef-File-zephyr.elf GENERATED_FROM SPDXRef-File-dev-handles.c
Relationship: SPDXRef-File-zephyr.elf GENERATED_FROM SPDXRef-File-isr-tables.c
Relationship: SPDXRef-File-zephyr.elf STATIC_LINK SPDXRef-File-libapp.a
Relationship: SPDXRef-File-zephyr.elf STATIC_LINK SPDXRef-File-libzephyr.a
Relationship: SPDXRef-File-zephyr.elf STATIC_LINK SPDXRef-File-libisr-tables.a
Relationship: SPDXRef-File-zephyr.elf STATIC_LINK SPDXRef-File-libkernel.a
[...]
```

Automating 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
```

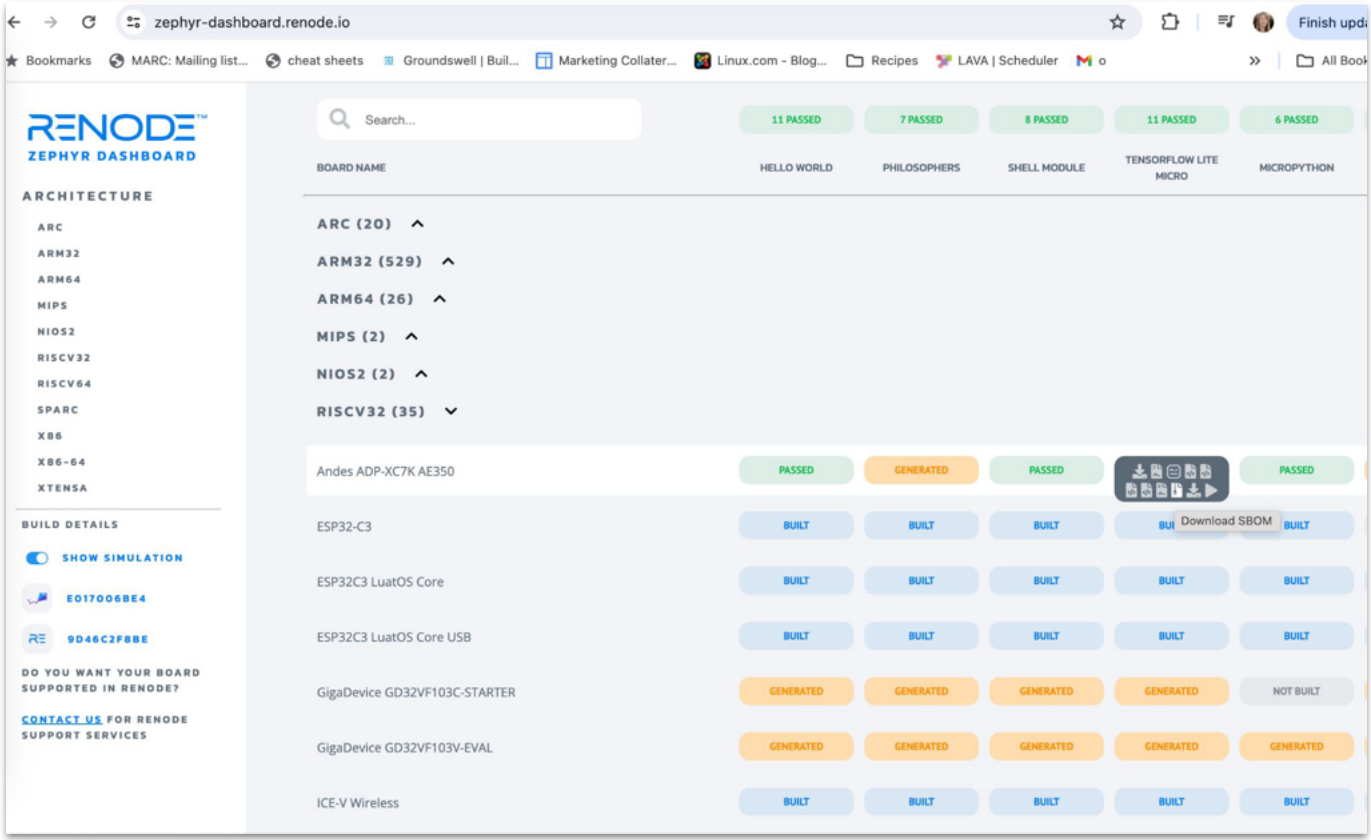
`zephyr.spdx`	SBOM for the **Zephyr source files** actually used by your application
`app.spdx`	SBOM for the source files of your **application**
`build.spdx`	SBOM for **all the build objects**, inc. of course your final image

SBOM's at Scale...Automatically

708 boards

13 apps

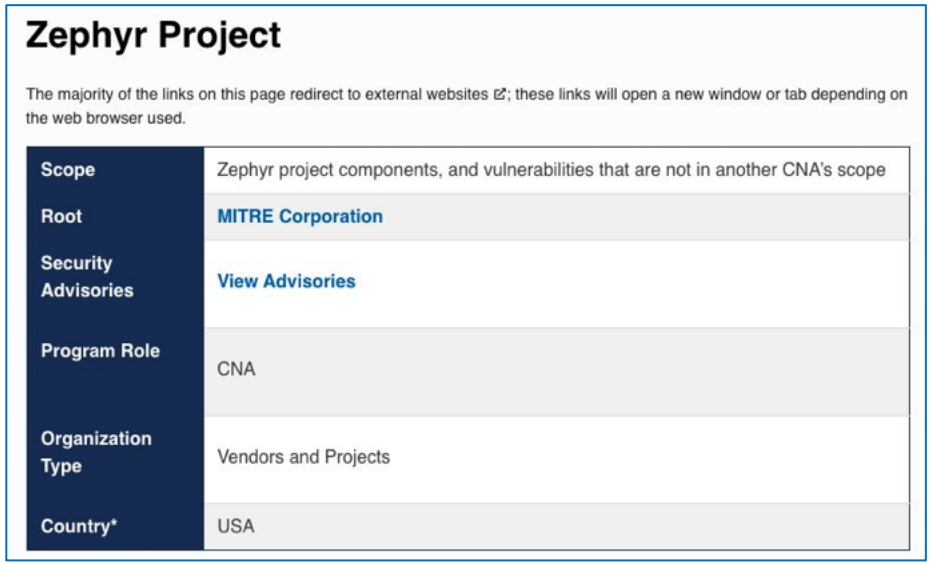
All BUILT, PASSED, GENERATED have **3 SBOM**s available to download & inspect



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

CVE Numbering Authority

- **Registered with MITRE** in 2017
  - We issue our own CVEs
- **Zephyr Project Security Incident Response Team** (PSIRT)
  - Volunteers from the Security Subcommittee led by the Zephyr Security Architect.



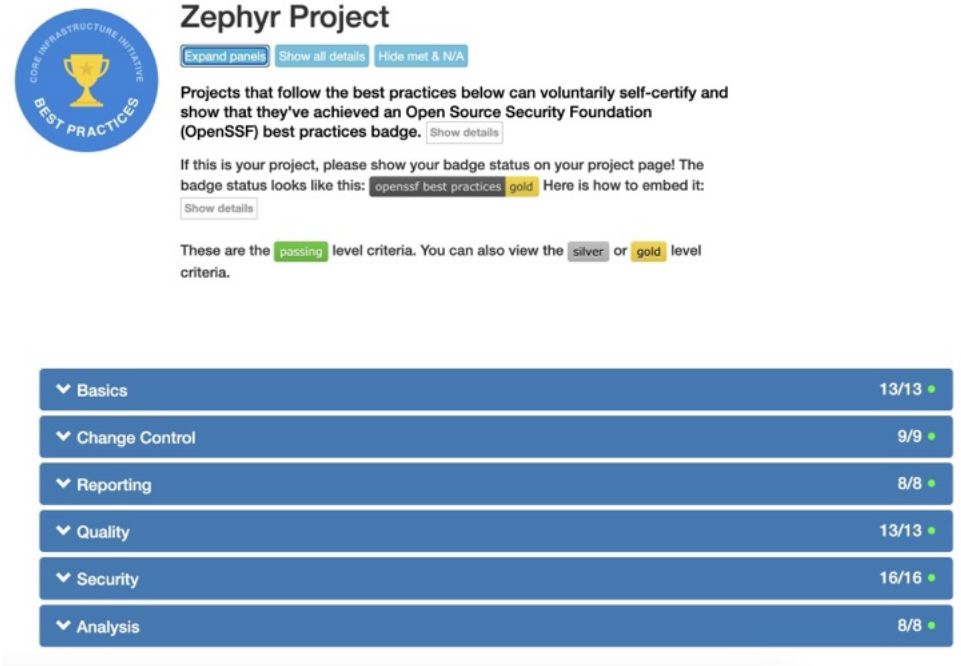
Zephyr Project

The majority of the links on this page redirect to external websites; these links will open a new window or tab depending on the web browser used.

Scope	Zephyr project components, and vulnerabilities that are not in another CNA's scope
Root	MITRE Corporation
Security Advisories	View Advisories
Program Role	CNA
Organization Type	Vendors and Projects
Country*	USA

OpenSSF Gold Badge

- Core Infrastructure Initiative
  Best Practices Program
- Awards badges based on “project commitment to security”
- Mostly about project infrastructure: is project hosting, etc following security practices
- Gold status since Feb, 2019



Vulnerability Alert Registry

- For an **embargo** to be effective, product makers need to be **notified early** so they can **remediate**
- The project aims at **fixing issues within 30 days** to give **vendors 60 days** before publication of vulnerability

zephyrproject.org/vulnerability-registry

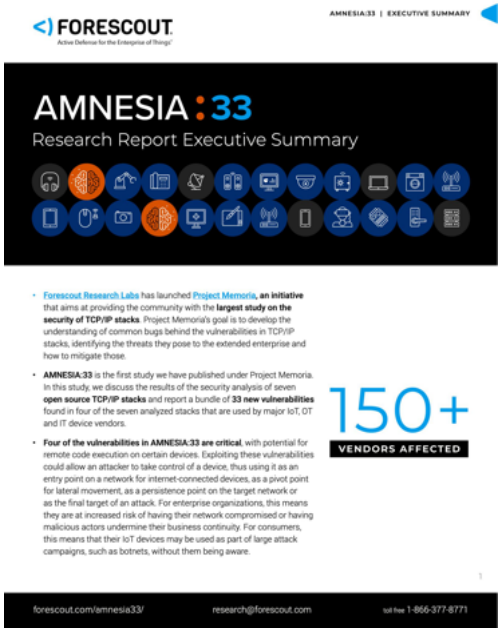
Zephyr PSIRT: Remediation and Response

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.

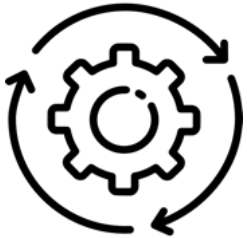


zephyrproject.org/zephyr-security-update-on-amnesia33

Zephyr Security Summary

[Documented secure coding practices]

Vulnerability response criteria publicly documented

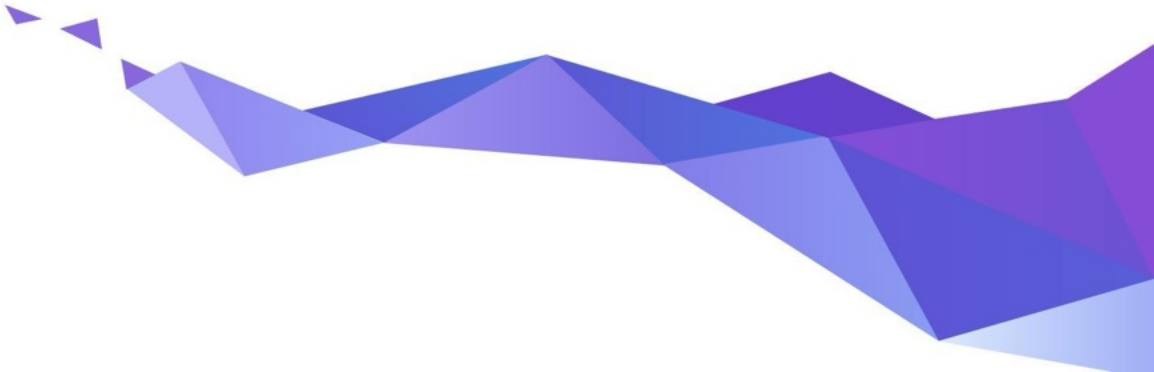


Weekly Coverity scans

MISRA scans

SBOM generation

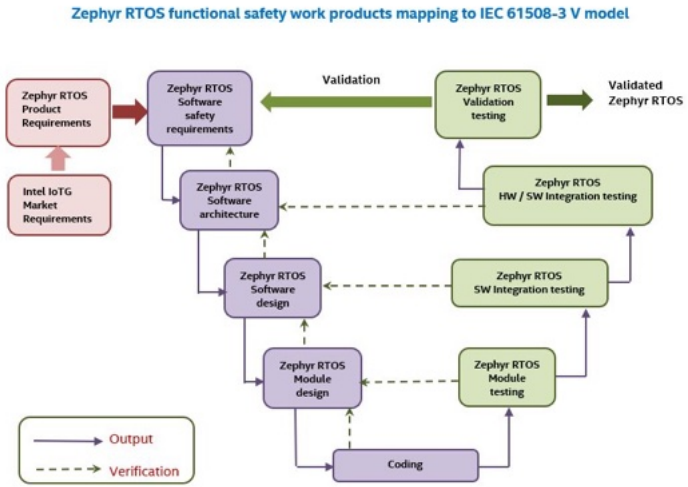
Certification



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



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

Safety Collateral Proposal

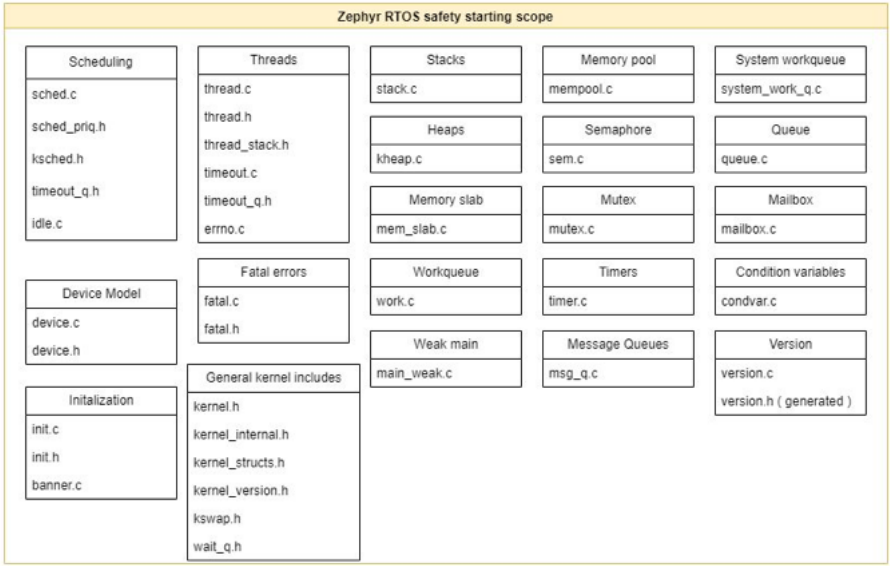
Zephyr®

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 Assesment 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) that are applicable to safety scope is managed by the safety committee.
- Other project artifacts have owners designated.

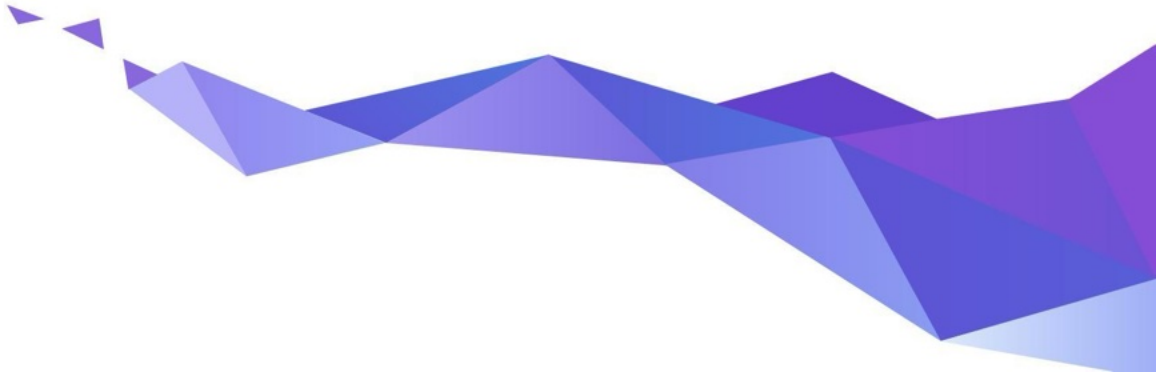
Initial certification focus

- 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 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

Ecosystem & Governance



Zephyr Project: Platinum Members

ANALOG DEVICES

antmicro

CARIAD
A VOLKSWAGEN GROUP COMPANY

Google

intel.

Meta

NORDIC® SEMICONDUCTOR

NXP

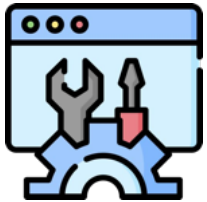
oticon
life-changing technology

Qualcomm Innovation Center

ZEISS

Zephyr Project: Silver Members

Vibrant Ecosystem



Development Tools

Governing Board

Technical Steering Committee

Contributors

Applications & Middlewares

Training & Consulting

Firmwares & Libraries

Ecosystem // Developer Tools

Zephyr®

Development Tools

Training & Consulting

Firmwares & Libraries

Applications & Middlewares

IDE






Compilers



Debuggers / Tracing Tools

Emulation / Simulation

Ecosystem // Training & Consulting

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Development Tools

Training & Consulting

Firmwares & Libraries

Applications & Middlewares

Training

NORDIC SEMICONDUCTOR

Golioth

THE LINUX FOUNDATION

percepio SENSING SOFTWARE

ac6

DOULOS

Savoir-faire LINUX

Services & Consulting

ANALOG DEVICES

antmicro

Baylibre

AVSYSTEM

ezurio

NXP

WNDRVR

Ecosystem // Firmwares & Libraries

Development Tools

Training & Consulting

Firmwares & Libraries

Applications & Middlewares

Security

wolfSSL

psacertified™

Mbed TLS

TrustedFirmware.org

TinyML

TensorFlow Lite

EDGE IMPULSE

Language runtimes

C++

JS

Rust

Lua

MicroPython

Others

SOUND OPEN FIRMWARE

zscilib

nRF Connect SDK

Memfault

Zenoh

Ecosystem // **Apps & Middlewares**

Zephyr®

Development Tools

Training & Consulting

Firmwares & Libraries

Applications & Middlewares

Remote Management

AVSYSTEM blues Blynk Golioth

HERALD Memfault STERNUM

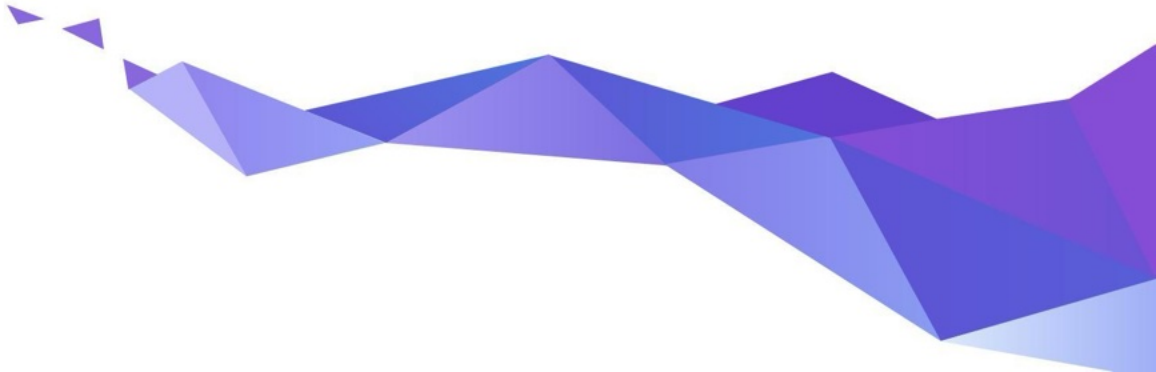
Graphical Interfaces

LVGL MICROEJ Qt Group slint

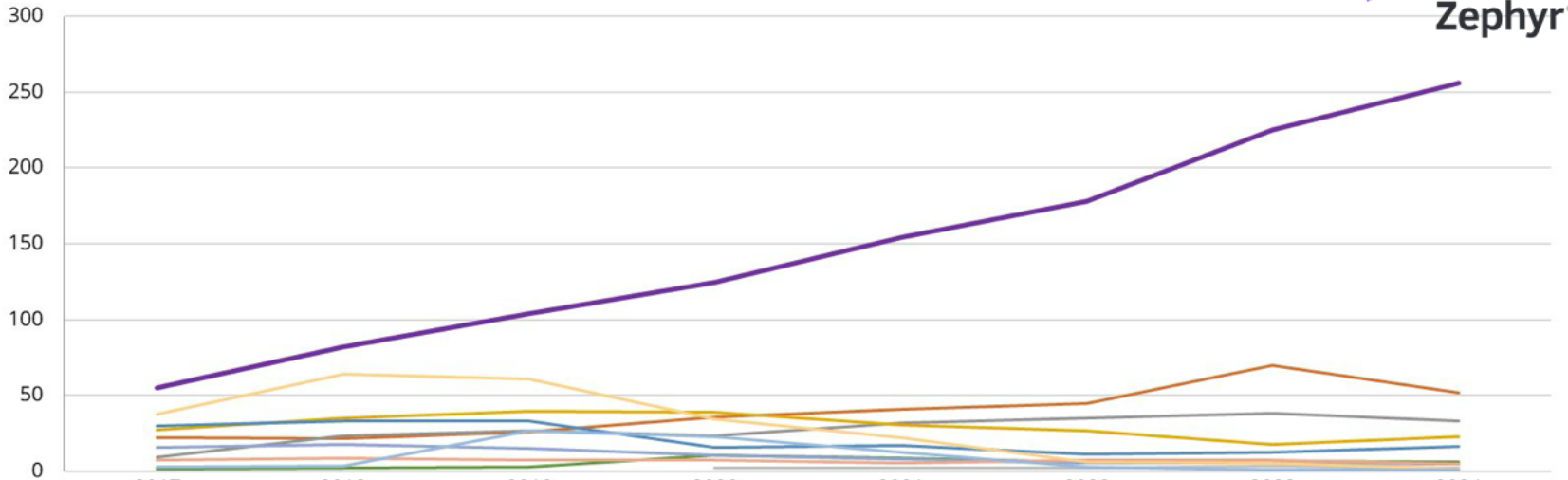
Robotics

ROS

Zephyr in the RTOS landscape

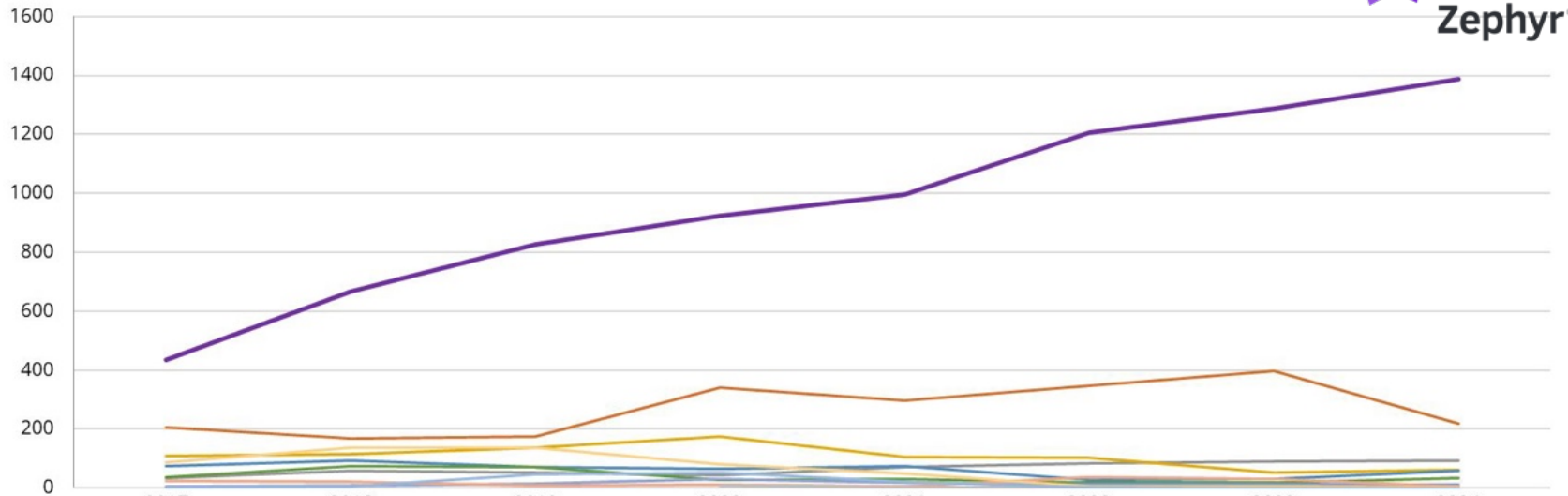


Average Number of Unique Contributors per Month

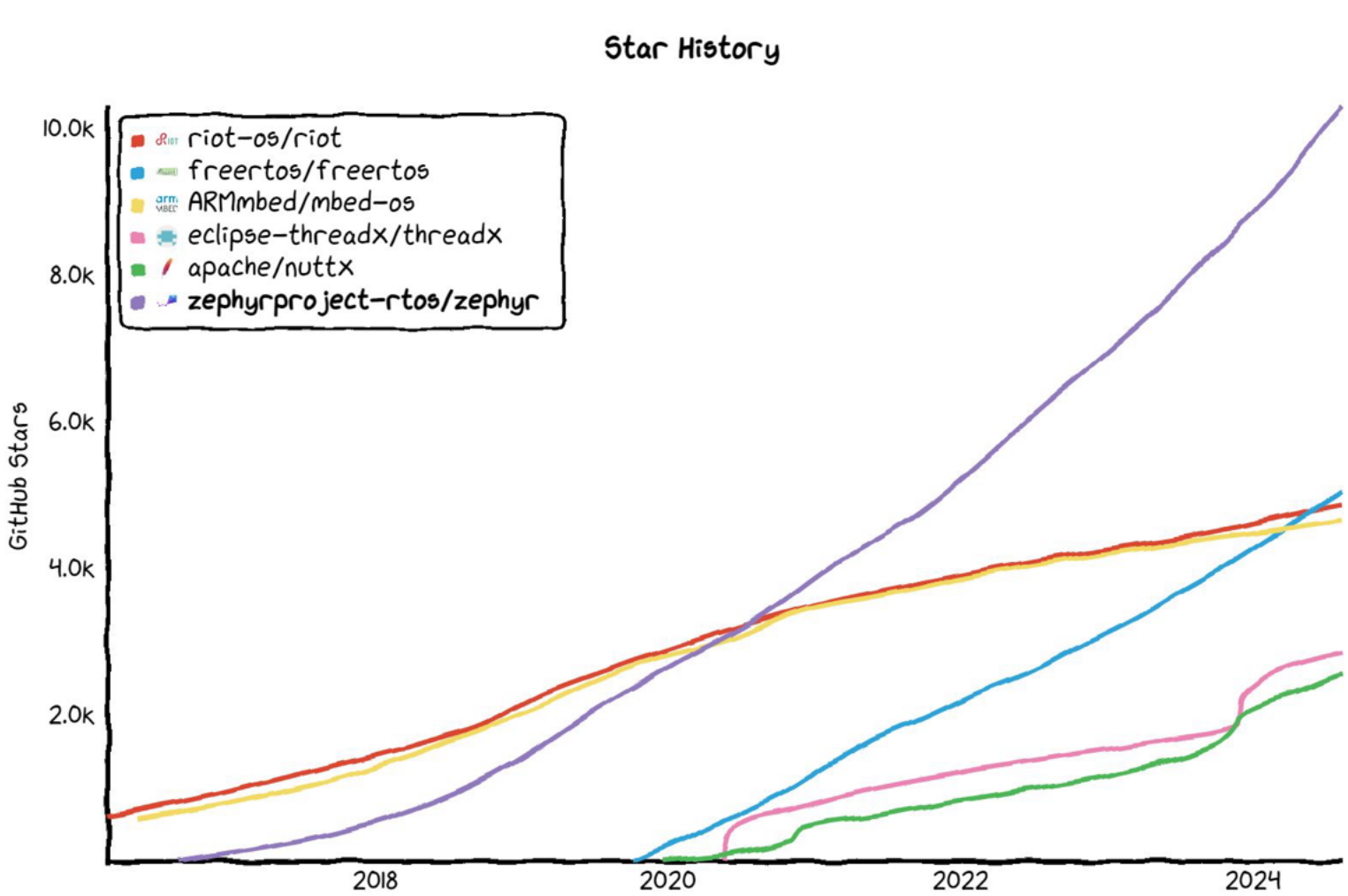


	2017	2018	2019	2020	2021	2022	2023	2024
Zephyr	55	82	104	125	154	178	225	256
Apache NuttX	22	22	26	36	41	45	70	52
RT-Thread	9	24	26	23	32	35	38	33
RIOT OS	27	35	39	39	30	27	18	23
TizenRT	30	33	33	15	17	11	13	16
FreeRTOS	2	2	3	11	8	6	7	6
Apache Mynewt	16	18	15	11	8	5	5	5
Contiki-NG	8	9	7	7	5	7	7	5
Eclipse 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



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GitHub Clones & Unique Visitors

2024-07-31 → 2024-08–13

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

Getting started – Important links

- Check out the official **Getting Started Guide**
- Dig into the hundreds of **code samples**
- Check the catalog of 100s of available Devicetree bindings
  - No driver for your HW? Chances are a similar driver already exists and writing one is not as hard or daunting as you would think!
- Reach out to the community on **Discord**

Zephyr Participation Information

zephyrproject.org

github.com/zephyrproject-rtos

lists.zephyrproject.org

chat.zephyrproject.org

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