

POSIX Roadmap for Zephyr LTSv3

2024-04-16: EMBEDDED OPEN SOURCE SUMMIT
Seattle, WA

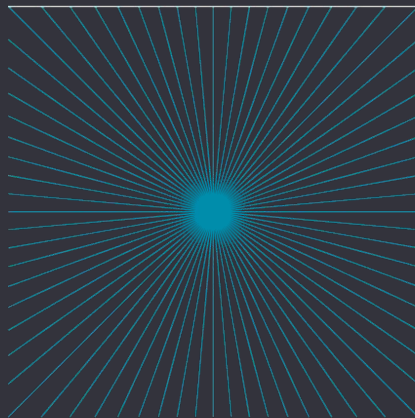
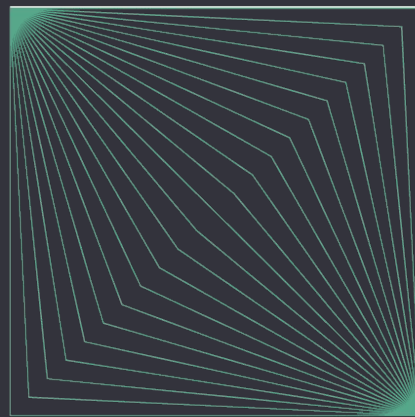
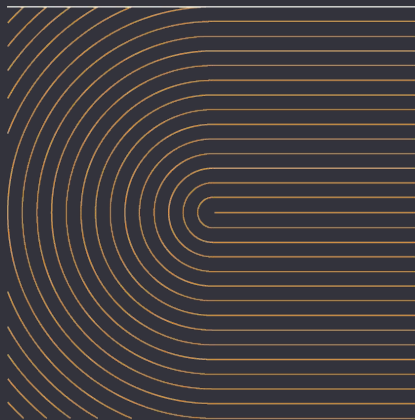
Chris Friedt
Staff Engineer, Firmware
Zephyr POSIX API Maintainer



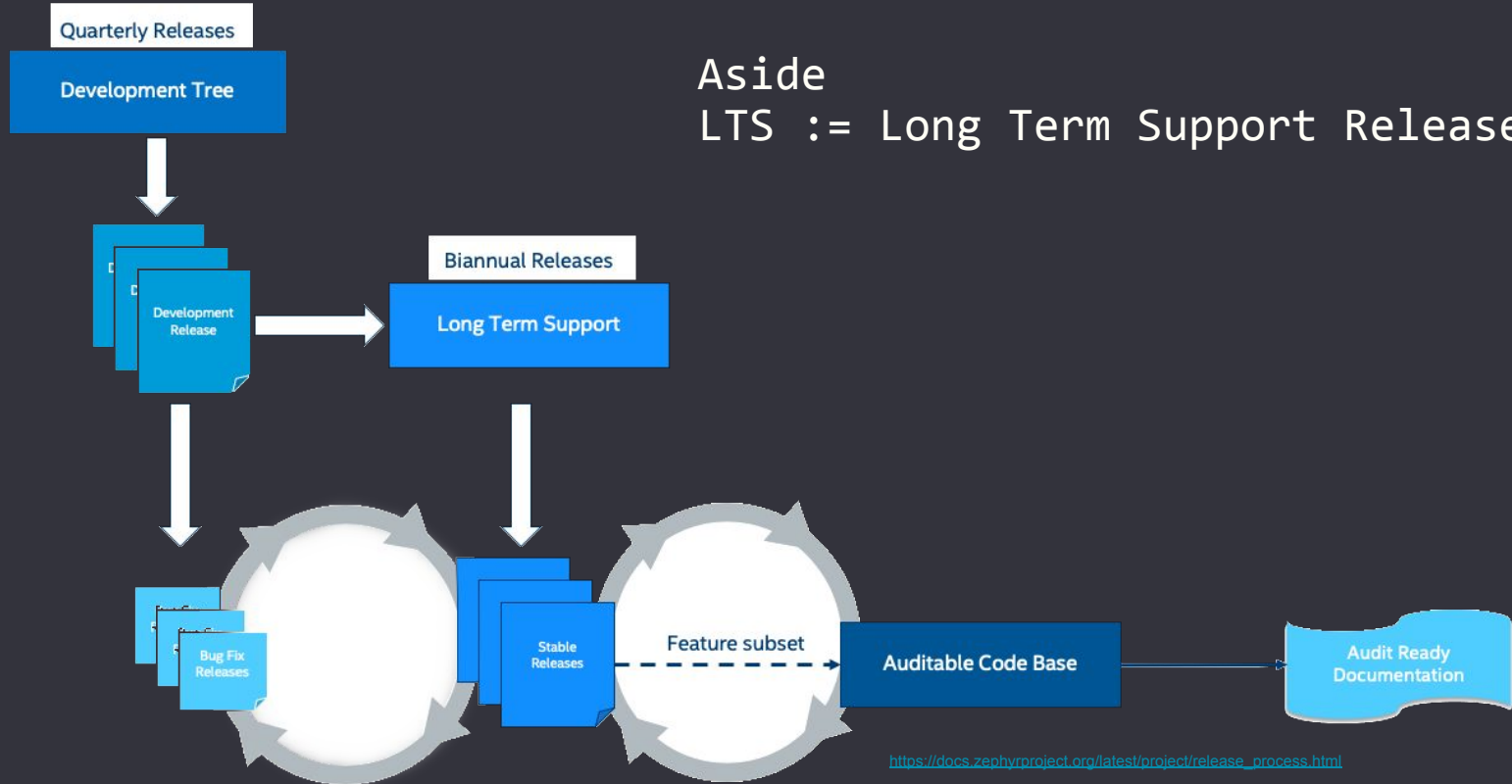
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Zephyr



Aside
LTS := Long Term Support Release





<https://www.etsy.com/listing/970247574/penguin-wearing-a-hawaiian-shirt>



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  THANK YOU, ZEPHYR
COMMUNITY  



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Agenda

- 01 Overview of POSIX in Zephyr
- 02 Goals for LTSv3
- 03 How it's Going
- 04 What Next?



01 Overview of POSIX in Zephyr



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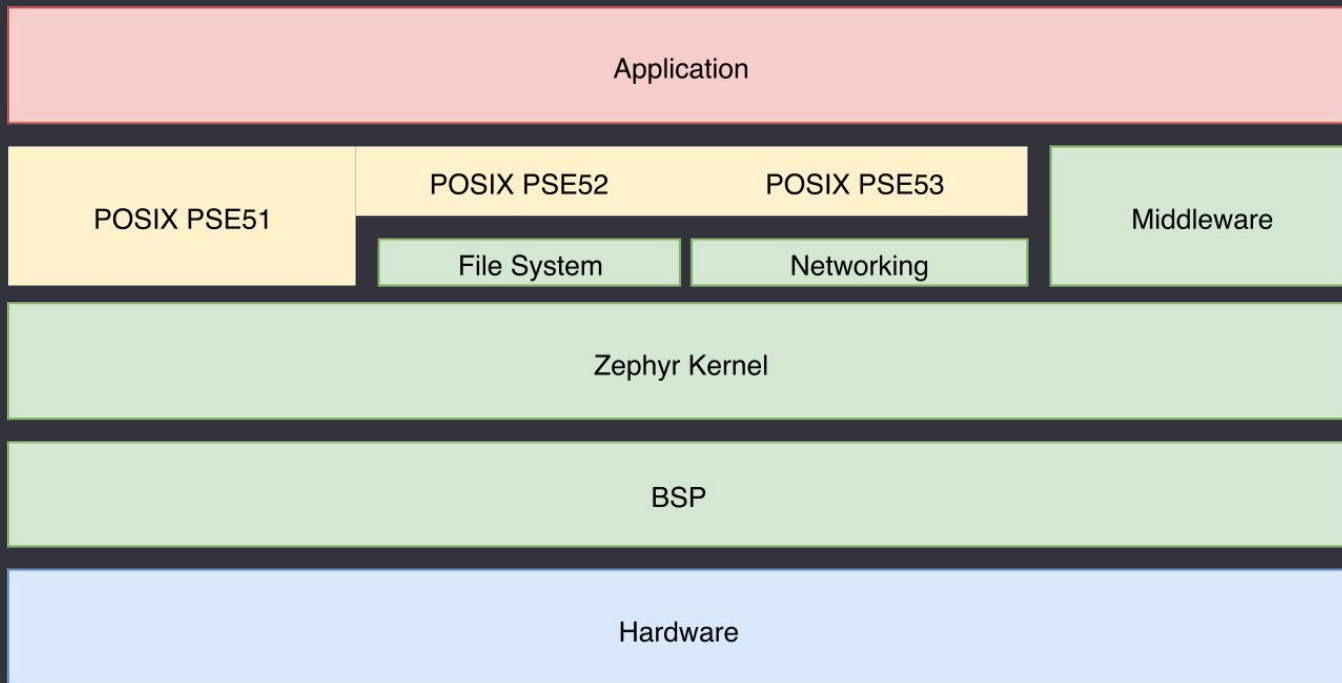
Zephyr

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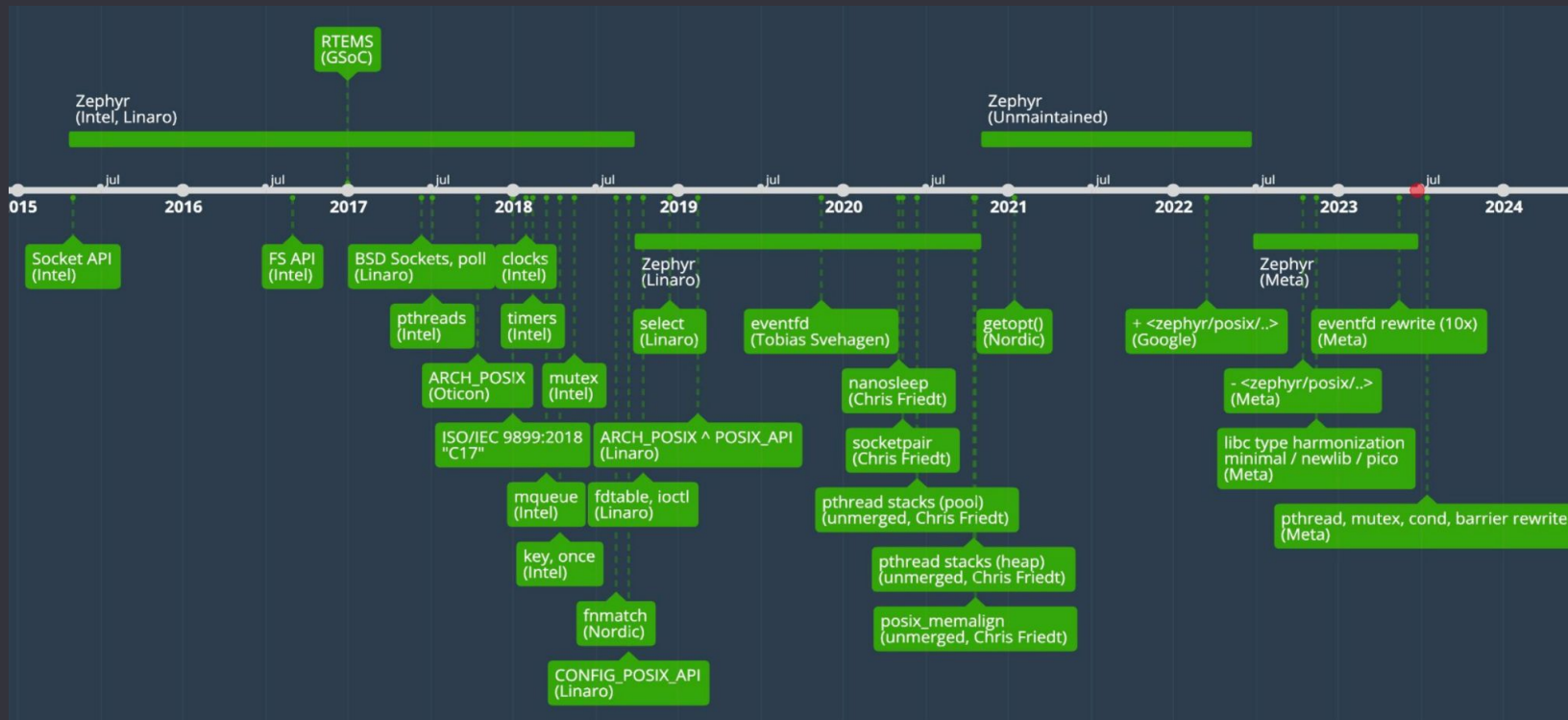
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01 Overview of POSIX in Zephyr



01 Overview of POSIX in Zephyr



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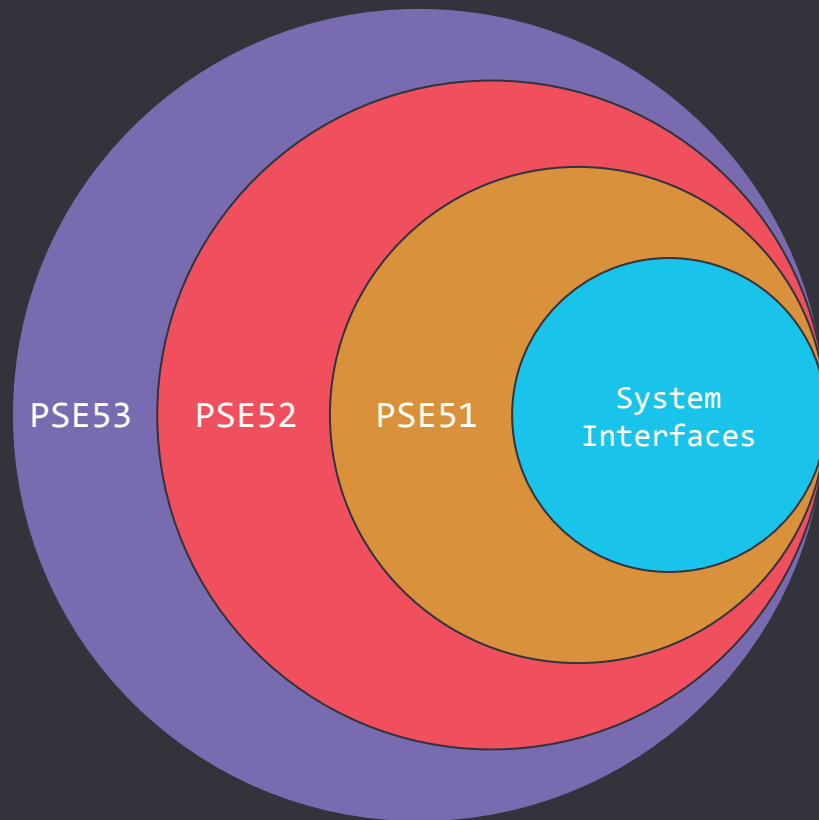
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01 Overview of POSIX in Zephyr

- Application Environment Profiles
- AEP / “PSE”
- [IEEE 1003.13-2003](#)
- Status: Inactive-Reserved
- Not depicted: PSE54
- [IEEE 1003.1-2017](#) (2008?)
- [System Interfaces](#)
- [Subprofiling Option Groups](#)
- PSE are defined by
 - Option Groups (no “_”)
 - Options (“_”)

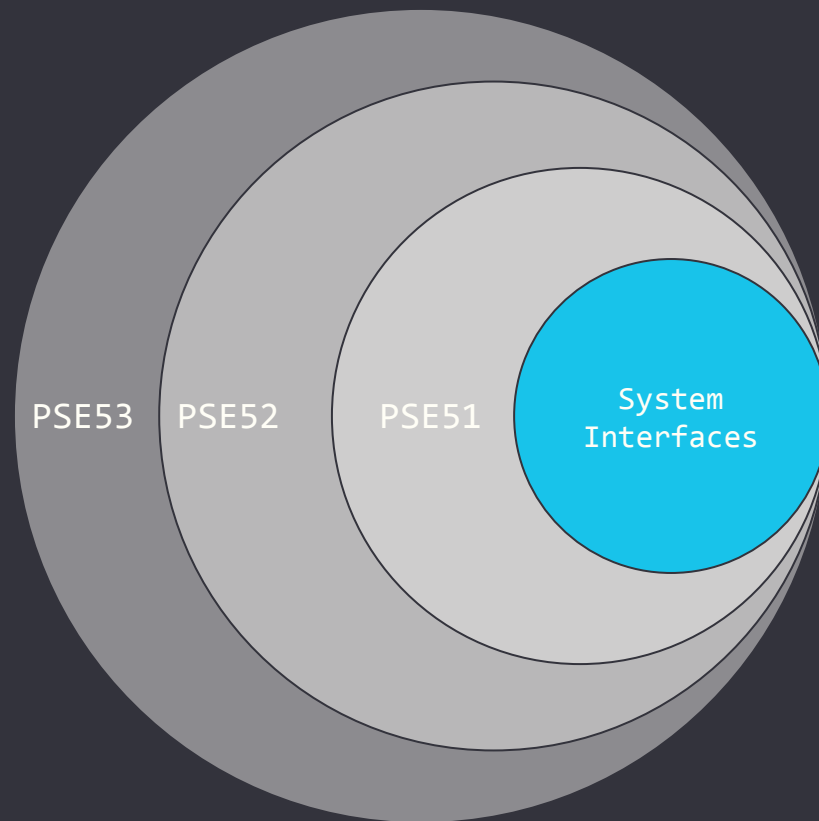


01 Overview of POSIX in Zephyr

System Interfaces

POSIX_C_LANG_JUMP
POSIX_C_LANG_SUPPORT

POSIX_ASYNCHRONOUS_IO
POSIX_BARRIERS
POSIX_CLOCK_SELECTION
POSIX_MAPPED_FILES
POSIX_MEMORY_PROTECTION
POSIX_READER_WRITER_LOCKS
POSIX_REALTIME_SIGNALS
POSIX_SEMAPHORES
POSIX_SPIN_LOCKS
POSIX_THREAD_SAFE_FUNCTIONS
POSIX_THREADS
POSIX_TIMEOUTS
POSIX_TIMERS



01 Overview of POSIX in Zephyr

PSE51: Minimal Realtime System

POSIX_DEVICE_IO

POSIX_FILE_LOCKING

POSIX_SIGNALS

POSIX_SINGLE_PROCESS

XSI_THREADS_EXT

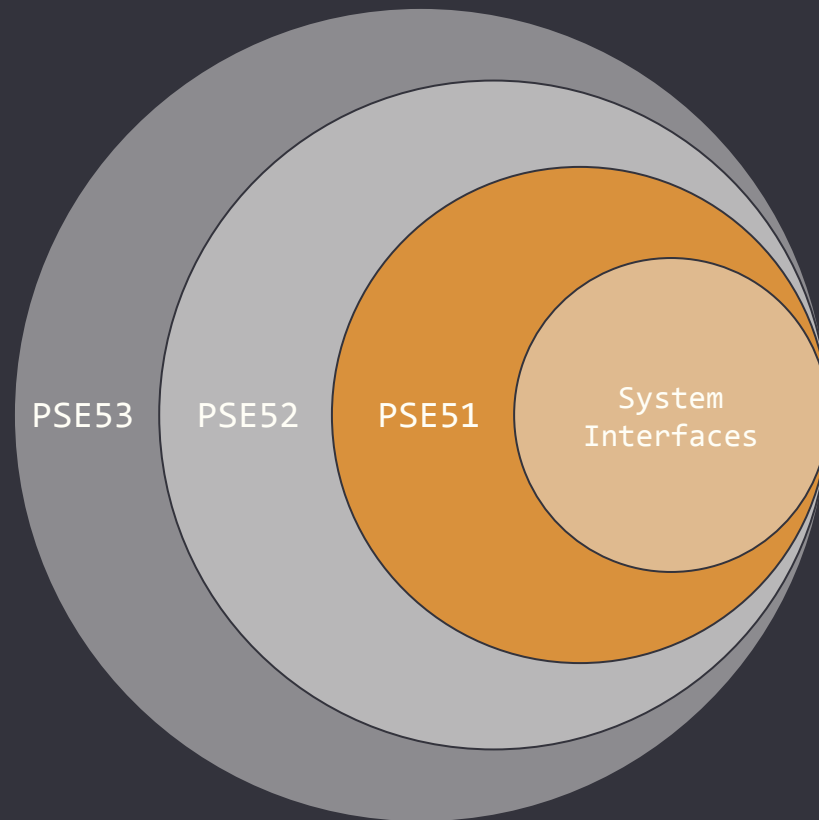
POSIX_FSYNC

POSIX_MEMLOCK

POSIX_MONOTONIC_CLOCK

POSIX_MESSAGE_PASSING

POSIX_SHARED_MEMORY_OBJECTS



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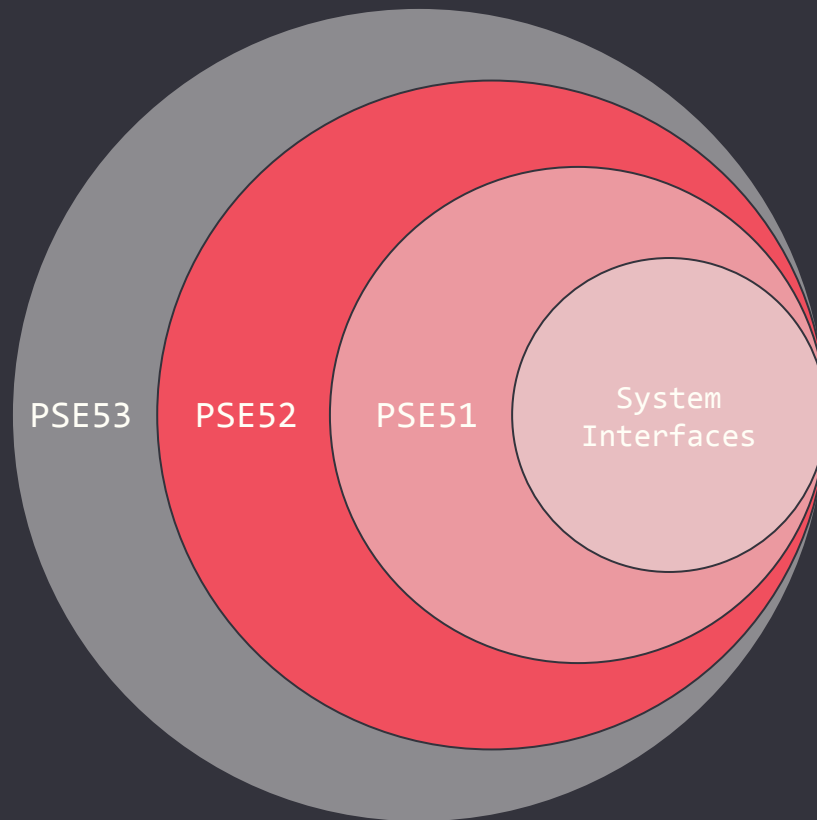
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01 Overview of POSIX in Zephyr

PSE52: Realtime Controller System

POSIX_C_LANG_MATH
POSIX_FD_MGMT
POSIX_FILE_SYSTEM

_POSIX_MAPPED_FILES
POSIX_MESSAGE_PASSING
_POSIX_TRACE



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01 Overview of POSIX in Zephyr

PSE53: Dedicated Realtime System

POSIX_MULTI_PROCESS†

POSIX_NETWORKING

POSIX_PIPE

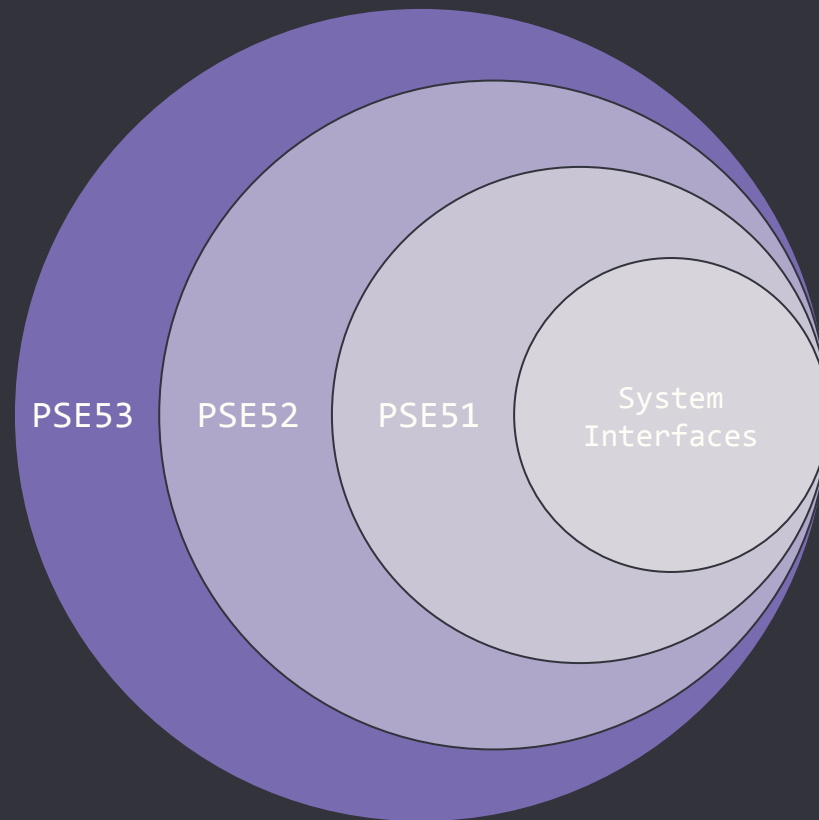
POSIX_SIGNAL_JUMP

_POSIX_CPUTIME

_POSIX_PRIORITIZED_IO†

_POSIX_RAW_SOCKETS

_POSIX_SPORADIC_SERVER†



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01 Overview of POSIX in Zephyr

Why POSIX?

- Portable, Mature API
- Model for network stacks**, Zephyr scheduler, FS
- Powers 2B*   
- Powers 16B* Mobile 
- Powers 1B* 



*very rough estimate

**initially developed with POSIX, now native zephyr



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02 Goals for LTSv3



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02 Goals for LTSv3

- Implement all required [POSIX System Interfaces](#) from the Base Definitions
- Support for [PSE51](#), [PSE52](#), [PSE53](#)
- Improve
 - **Maintainability**
 - Conformance / Interface
 - Application / Library Portability
 - [Documentation](#)



03 How it's Going



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03 How it's Going: Maintainability

- Organized sources
 - separate shell util dir
 - impl's moved to options dir
 - app conformance (in review)
 - impl conformance (planned)
- Ensure Kconfig options match POSIX spec (planned)
 - E.g. rename
CONFIG_PTHREAD_BARRIER
↔ CONFIG_POSIX_BARRIERS
↔ _POSIX_BARRIERS
- Simplifies sysconf()
 - O(1) space / time
 - Compile-time constant
- PSE Kconfig shortcuts (planned)
 - CONFIG_POSIX_AEP_REALTIME_MINIMAL
 - select required options via Kconfig
 - #define _POSIX_AEP_REALTIME_MINIMAL 200312L



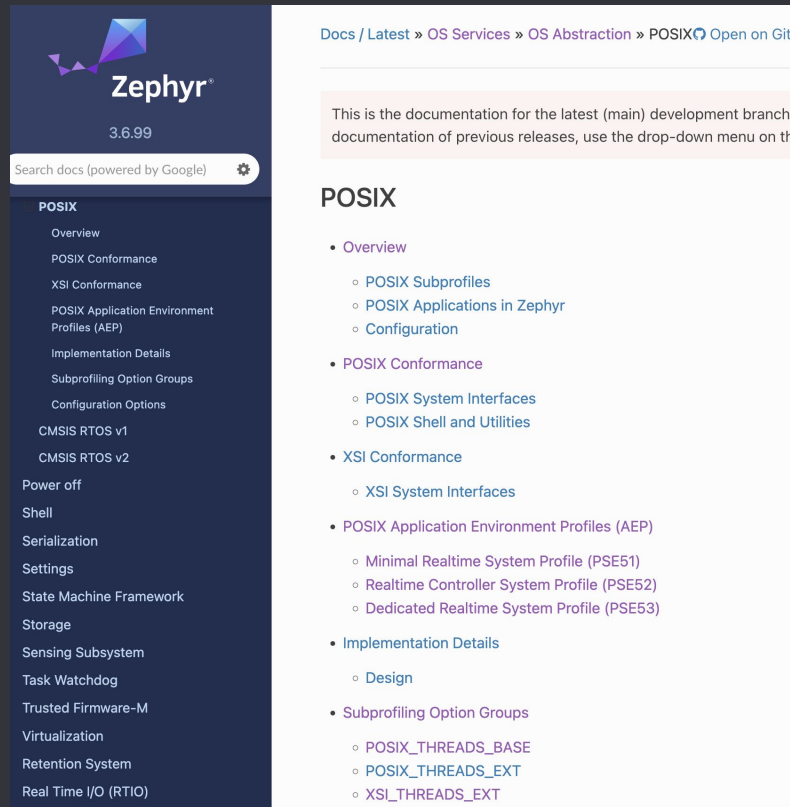
03 How it's Going: Portability

- Testsuite is kind of priceless
- Currently testing against 3 C libraries (minimal, picolibc, newlib)
- Should be possible to support C libraries without any explicit POSIX support (IAR volunteers?)
- Test LOC
 - EOSS 2023: ~7000
 - EOSS 2024: ~8000
- 100% coverage as of March 2024



03 How it's Going: Documentation

- Definitely an Improvement
- Don't forget to update docs in PRs please 🙏
- Doxygen Wizards needed 🧙



The screenshot displays the Zephyr documentation website. At the top, the Zephyr logo and version 3.6.99 are shown. A search bar indicates docs are powered by Google. A sidebar on the left lists various documentation topics, with 'POSIX' selected. The main content area shows the 'POSIX' section, which includes a list of sub-topics: Overview, POSIX Conformance, XSI Conformance, POSIX Application Environment Profiles (AEP), Implementation Details, Subprofiling Option Groups, Configuration Options, CMSIS RTOS v1, CMSIS RTOS v2, Power off, Shell, Serialization, Settings, State Machine Framework, Storage, Sensing Subsystem, Task Watchdog, Trusted Firmware-M, Virtualization, Retention System, and Real Time I/O (RTIO). The 'Overview' sub-section is expanded, showing a list of links for POSIX Subprofiles, POSIX Applications in Zephyr, Configuration, POSIX System Interfaces, POSIX Shell and Utilities, XSI System Interfaces, Minimal Realtime System Profile (PSE51), Realtime Controller System Profile (PSE52), Dedicated Realtime System Profile (PSE53), Design, and various thread-related topics.

Docs / Latest » OS Services » OS Abstraction » POSIX [Open on Git](#)

This is the documentation for the latest (main) development branch documentation of previous releases, use the drop-down menu on the

POSIX

- Overview
 - POSIX Subprofiles
 - POSIX Applications in Zephyr
 - Configuration
- POSIX Conformance
 - POSIX System Interfaces
 - POSIX Shell and Utilities
- XSI Conformance
 - XSI System Interfaces
- POSIX Application Environment Profiles (AEP)
 - Minimal Realtime System Profile (PSE51)
 - Realtime Controller System Profile (PSE52)
 - Dedicated Realtime System Profile (PSE53)
- Implementation Details
 - Design
- Subprofiling Option Groups
 - POSIX_THREADS_BASE
 - POSIX_THREADS_EXT
 - XSI_THREADS_EXT



03 How it's Going: Conformance: System Interfaces

<code>_POSIX_VERSION</code>		✓
<code>_POSIX_ASYNCHRONOUS_IO</code>	Not supported for now. return -1 / ENOTSUP	✓
<u>_POSIX_BARRIERS</u>		✓
<u>_POSIX_CLOCK_SELECTION</u>		✓
<code>_POSIX_MAPPED_FILES</code>	Need <u>mmap()</u> , <u>munmap()</u>	●
<code>_POSIX_MEMORY_PROTECTION</code>	Need <u>mprotect()</u>	●
<u>_POSIX_READER_WRITER_LOCKS</u>		✓
<code>_POSIX_REALTIME_SIGNALS</code>	Need <u>sigqueue()</u> , <u>sigtimedwait()</u> , <u>sigwaitinfo()</u> - in progress	✓



03 How it's Going: Conformance: System Interfaces

<u>_POSIX_SEMAPHORES</u>		✓
<u>_POSIX_SPIN_LOCKS</u>		✓
<u>_POSIX_THREAD_SAFE_FUNCTIONS</u>	Low-hanging fruit - create a PR!	●
<u>_POSIX_THREADS</u>	Need <u>pthread_kill()</u> - last one 😊	✓
<u>_POSIX_TIMEOUTS</u>		✓
<u>_POSIX_TIMERS</u>		✓



03 How it's Going: Conformance: PSE51 Option Groups: 75%

POSIX_C_LANG_JUMP		✓
POSIX_C_LANG_SUPPORT		✓
POSIX_DEVICE_IO	In progress!	●
POSIX_FILE_LOCKING	Good first issue / trivial	●
POSIX_SIGNALS	In progress!	✓
POSIX_SINGLE_PROCESS		✓
POSIX_THREADS_BASE		✓
XSI_THREADS_EXT		✓



03 How it's Going: Conformance: PSE51 Options: 83%

_POSIX_CLOCK_SELECTION	✓	_POSIX_THREAD_ATTR_STACKADDR	✓
_POSIX_FSYNC	✓	_POSIX_THREAD_ATTR_STACKSIZE	✓
_POSIX_MEMLOCK	●	_POSIX_THREAD_CPUTIME	●
_POSIX_MEMLOCK_RANGE	●	_POSIX_THREAD_PRIO_INHERIT	✓
_POSIX_MONOTONIC_CLOCK	✓	_POSIX_THREAD_PRIO_PROTECT	✓
_POSIX_REALTIME_SIGNALS*	✓	_POSIX_THREAD_PRIORITY_SCHEDULING	✓
_POSIX_SEMAPHORES	✓	_POSIX_THREAD_SPORADIC_SERVER	✓
_POSIX_SHARED_MEMORY_OBJECTS	✓	_POSIX_TIMEOUTS	✓
_POSIX_SYNCHRONIZED_IO*	✓	_POSIX_TIMERS	✓

* currently in progress



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03 How it's Going: Conformance: PSE52 Option Groups: 80%*

POSIX_C_LANG_MATH		✓
POSIX_FD_MGMT	In progress!	🟡
POSIX_FILE_SYSTEM	Partially done / in progress	🟡

* inclusive of PSE51 Option Groups and including partially done items



03 How it's Going: Conformance: PSE52 Options: 72%*

_POSIX_MAPPED_FILES	🟡
_POSIX_MESSAGE_PASSING	✅
_POSIX_SHARED_MEMORY_OBJECTS	🟡
_POSIX_TRACE	🟡

* inclusive of PSE51 Options



03 How it's Going: Conformance: PSE53 Option Groups: 67%*

POSIX_MULTI_PROCESS†	Need stubs / no process support	🟡
POSIX_NETWORKING		✅
POSIX_PIPE	Good first issue!	🟡
POSIX_SIGNAL_JUMP	Good first issue!	🟡

* inclusive of PSE51 and PSE52 Option Groups



03 How it's Going: Conformance: PSE53 Options: 66%*

_POSIX_CPUTIME	✓
_POSIX_PRIORITIZED_IO†	✓
_POSIX_RAW_SOCKETS	✓
_POSIX_SPORADIC_SERVER†	●
_POSIX_MONOTONIC_CLOCK	✓
_POSIX_THREAD_SPORADIC_SERVER	✓
_POSIX_TRACE**	●
_POSIX_TRACE_EVENT_FILTER**	●
_POSIX_TRACE_LOG**	●

* inclusive of PSE51 and PSE52 Options

** Might do ENOTSUP and recommend Zephyr tracing for now



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03 How it's Going: Predictions for LTSv3 Release

- [POSIX System Interfaces](#) ✓
- [PSE51](#) ✓, [PSE52](#) ✓, [PSE53](#) ✓
- Improve
 - Maintainability ✓
 - Conformance / Interface ✓
 - Application / Library Portability ✓
 - [Documentation](#) ✓
 - Could use doxygen that's a big job
- Will we be certifiable for AutoSAR?
 - Probably not `_(\ツ)_/`
 - a good place to start tuning-up!



04 What next?



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04 What next?

Big Ticket Items

- Signals 
 - In progress
 - Some kernel components
 - Thread-to-thread
 - Queued-only for simplified RT support
- ZVFS 
 - common file ops in 1 library
 - to be used by posix, network, fs
 - mainly just moving code
- Doxygen 



04 What next?

CALL TO ACTION 💪 🎨

- Create tasks in GitHub
- e.g. [posix: implement putmsg #66979](#)
- Make Chris & Yong Cong review your code!! 😊
- Way too much spare time!! 😂 🤔



<https://listensd.com/when-we-were-young-2023/>



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Safety Critical Applications

- Adaptive AutoSAR
- ARINC 653
- DSO-178C + FACE

- Companies want to certify Linux+Zephyr in these areas



04 What next?

Everyone Wants AI 🤖

- Intelligent vehicles, Hyperscalar Infrastructure, Utilities, Mobile, Edge
- I know of a great AI Company
- Certification demands auditability

The future is Open Source



<https://tensorrent.com/cards/>



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Q/A



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From EOSS 2023: UNIX turned 50 years old

The Way Back Machine..



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From EOSS 2023

POSIX Turns 35 Years Old!



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