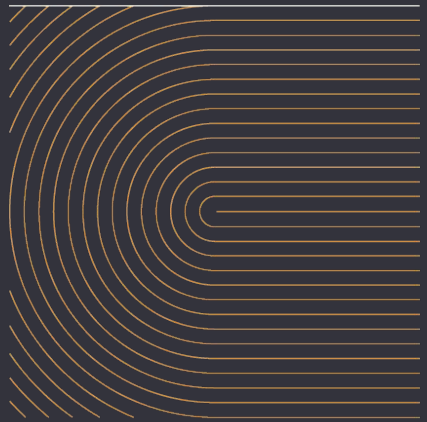
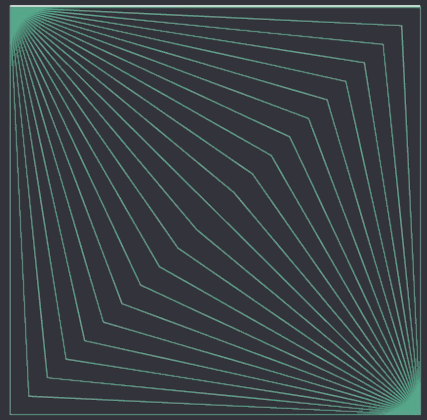
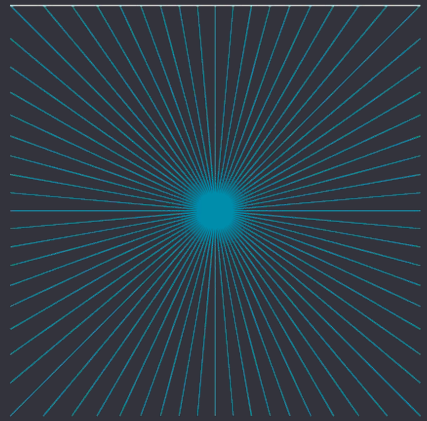
POSIX Roadmap for Zephyr LTSv3







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

Chris Friedt
Staff Engineer, Firmware
Zephyr POSIX API Maintainer

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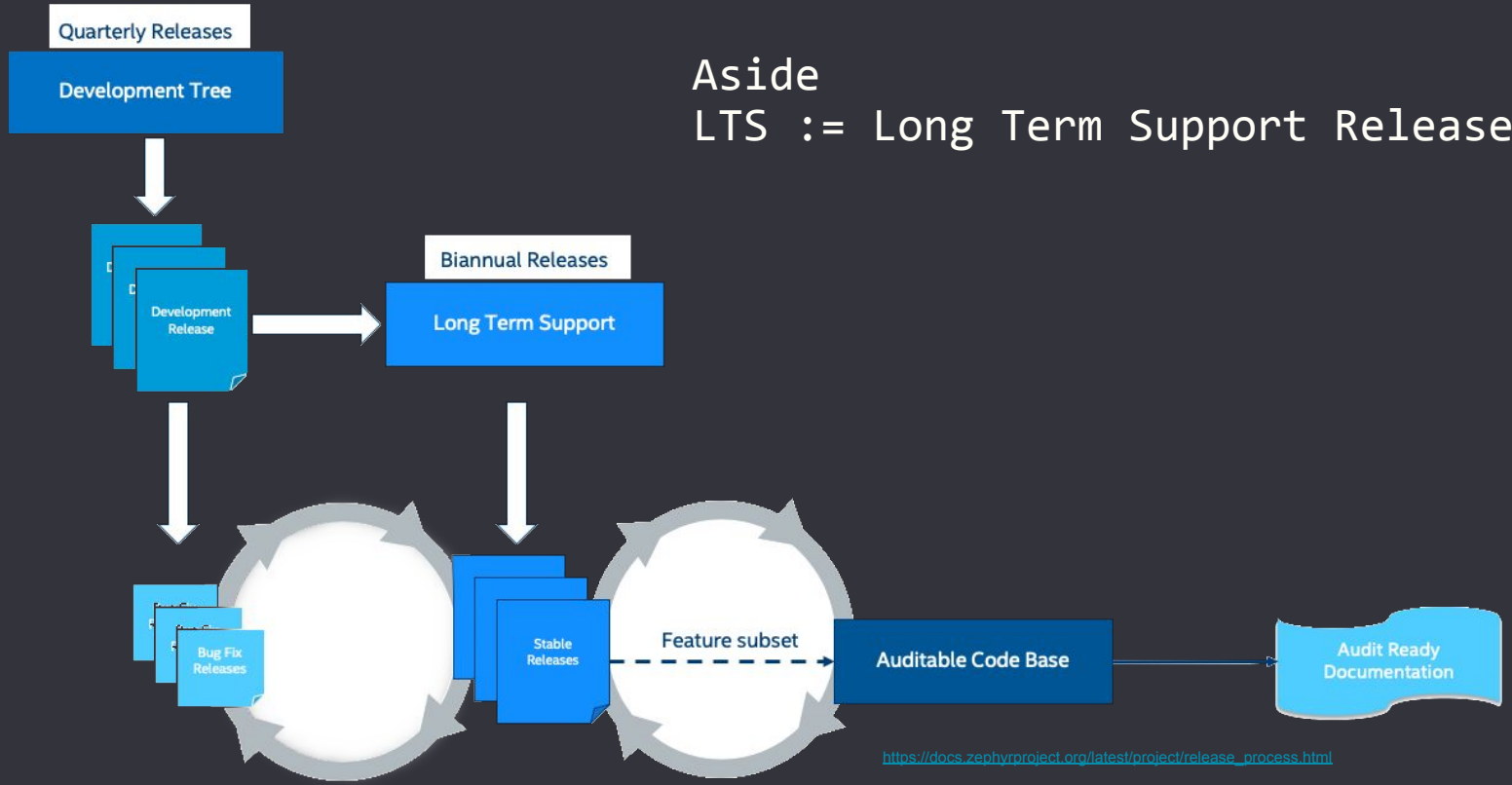
Zephyr

Aside
LTS := Long Term Support Release



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

  THANK YOU, ZEPHYR COMMUNITY  

Agenda

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

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Zephyr

01 Overview of POSIX in Zephyr

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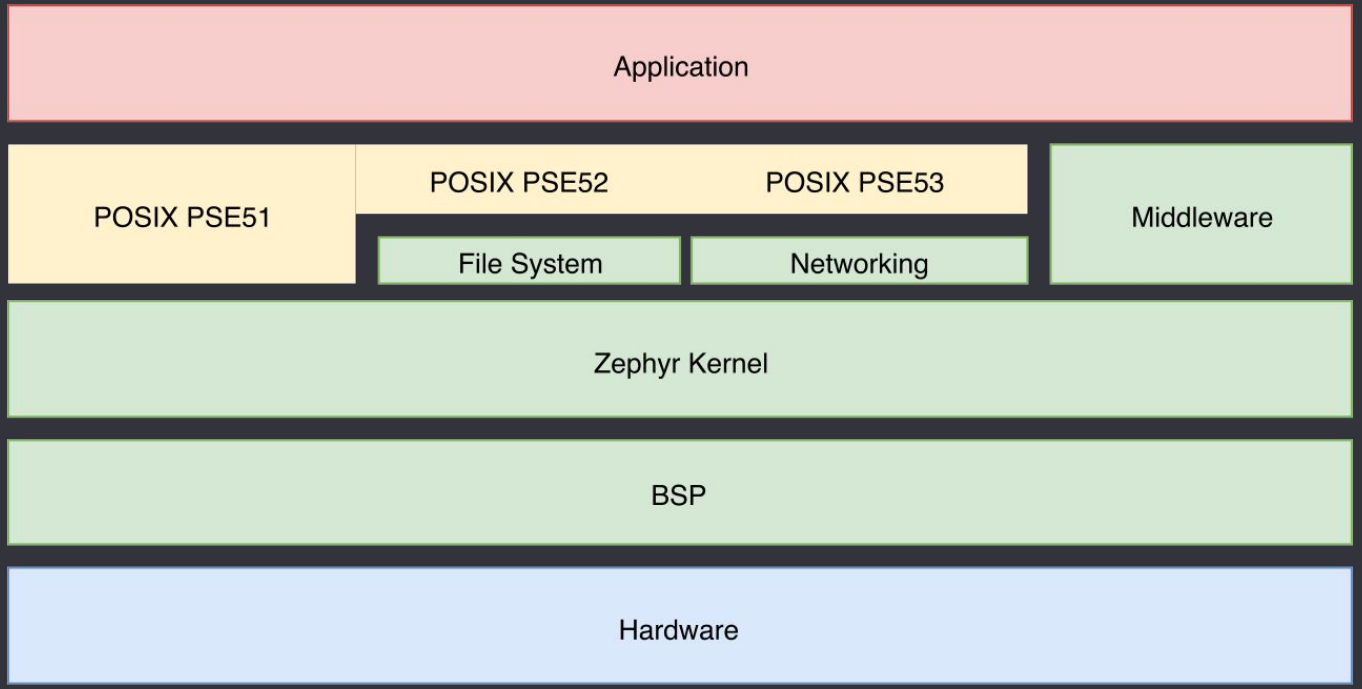
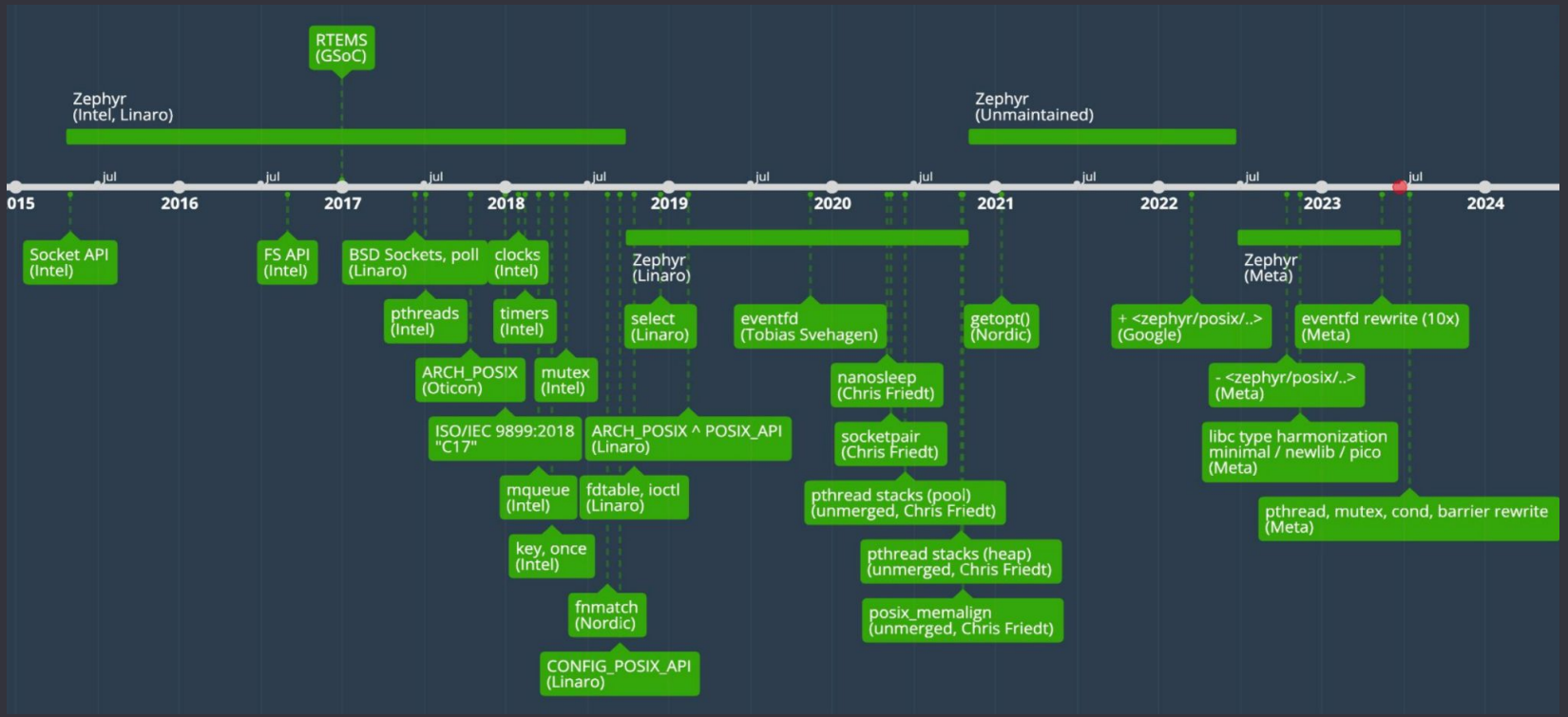
Zephyr

01 Overview of POSIX in Zephyr



01 Overview of POSIX in Zephyr



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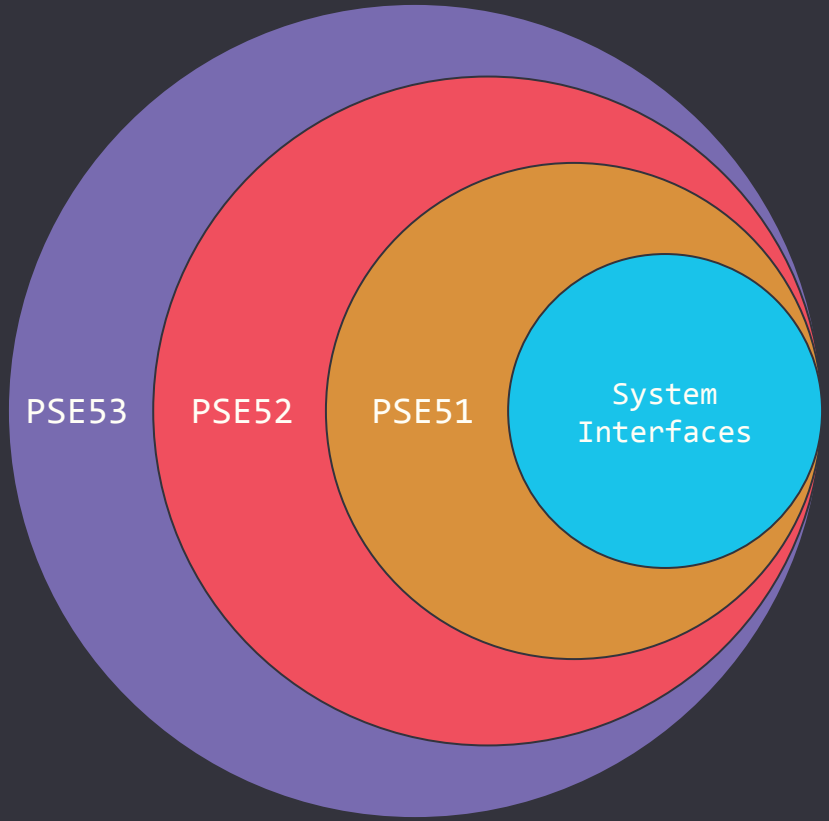
Zephyr

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 (“_”)

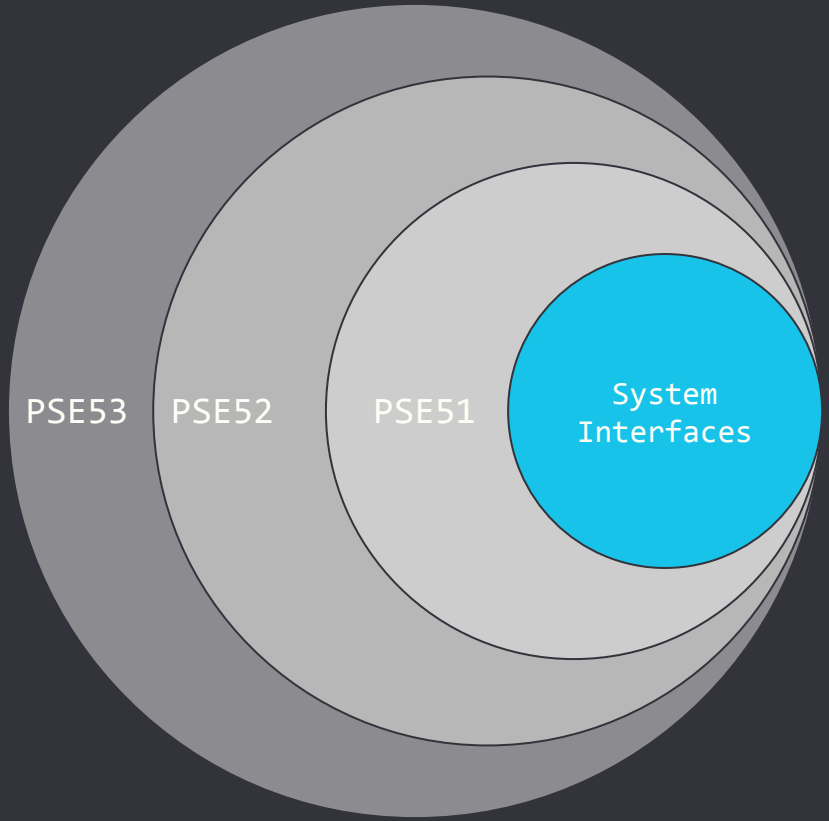


01 Overview of POSIX in Zephyr

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

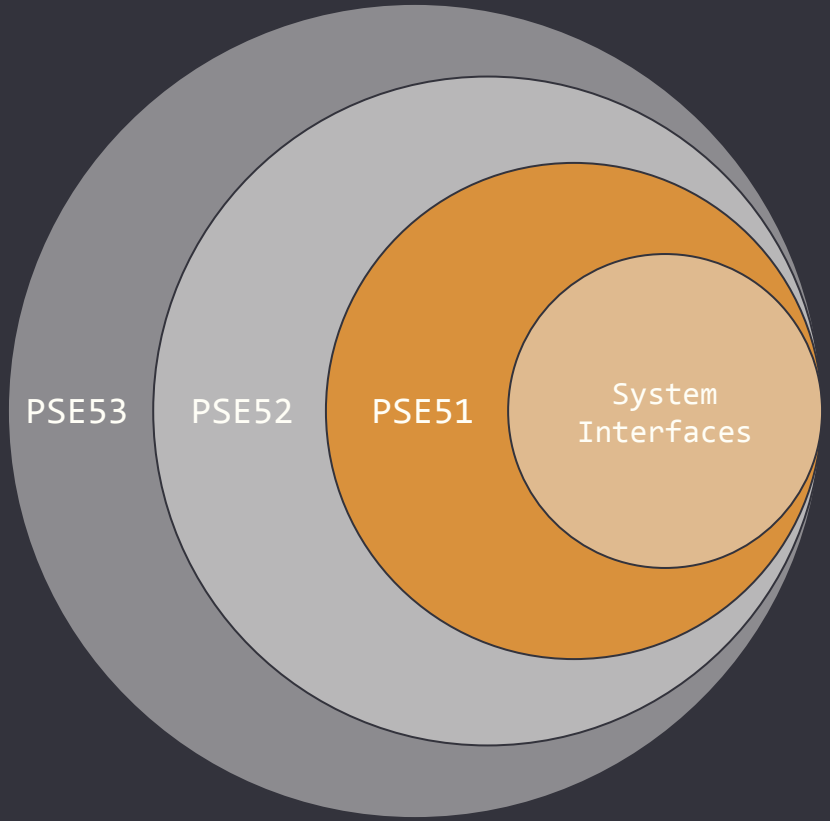


01 Overview of POSIX in Zephyr

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

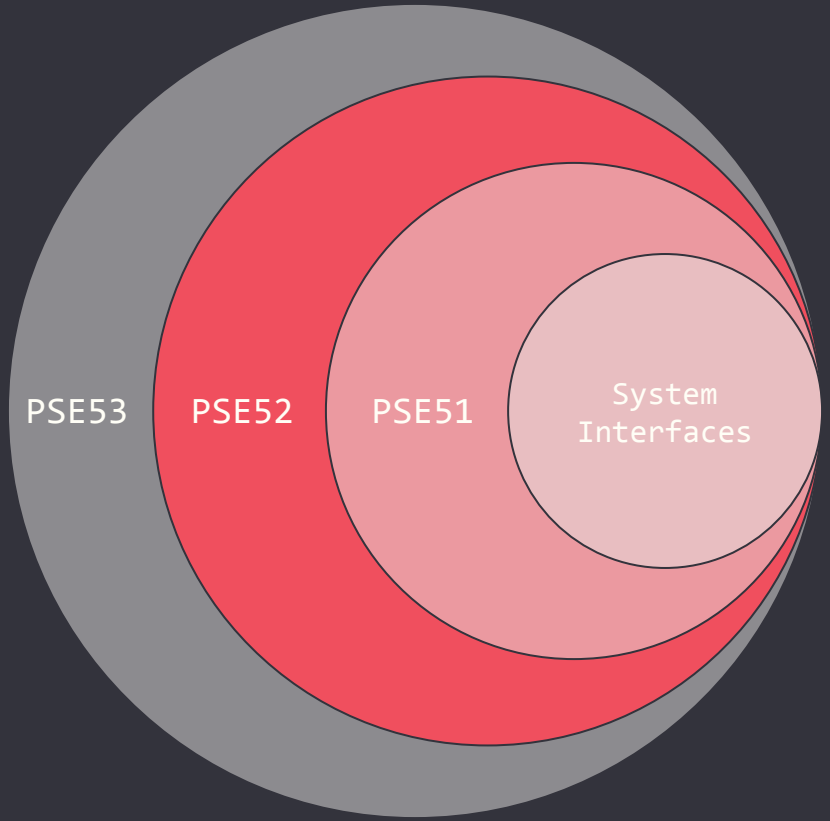


01 Overview of POSIX in Zephyr

PSE52: Realtime Controller System

POSIX_C_LANG_MATH
POSIX_FD_MGMT
POSIX_FILE_SYSTEM

_POSIX_MAPPED_FILES
_POSIX_MESSAGE_PASSING
_POSIX_TRACE

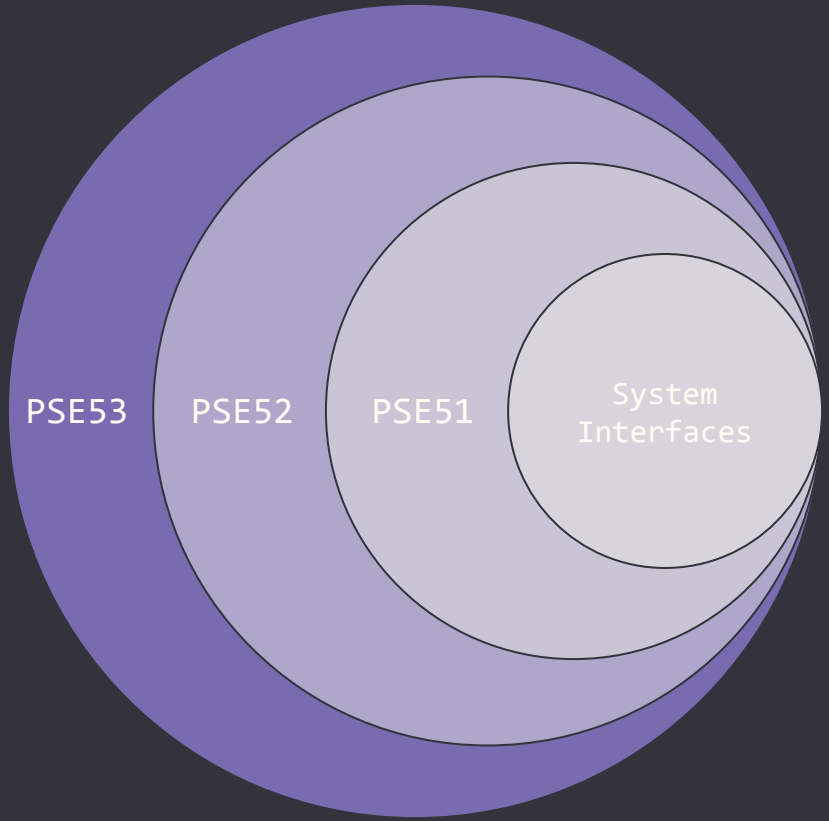


01 Overview of POSIX in Zephyr

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†



01 Overview of POSIX in Zephyr

Why POSIX?

- Portabile, 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

02 Goals for LTSv3

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

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Zephyr

03 How it’s Going

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

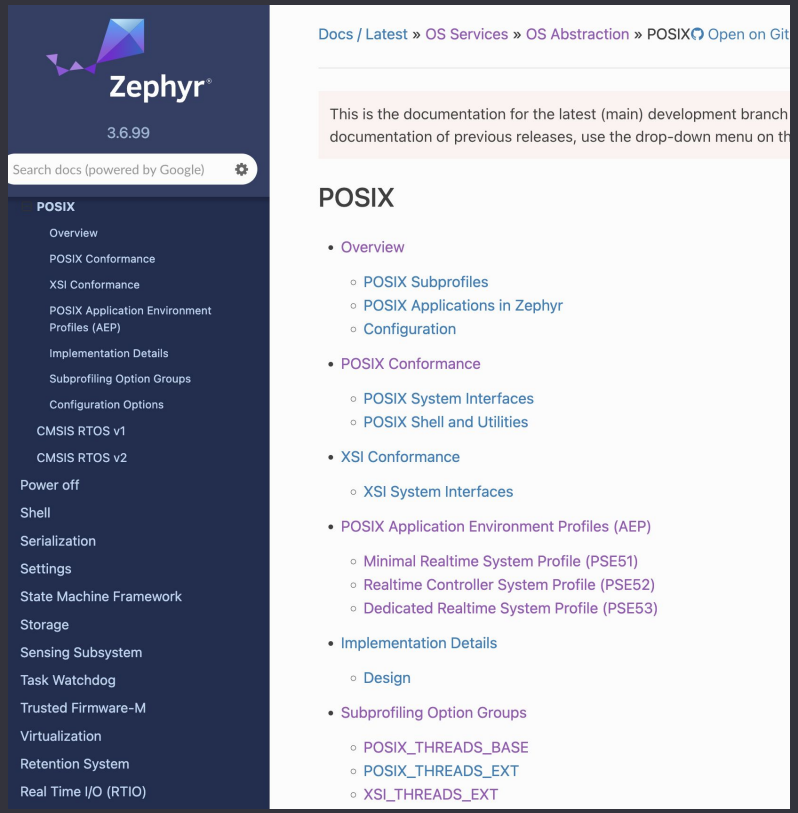
03 How it’s Going: Portability

- 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 🧙



03 How it’s Going: Conformance: System Interfaces

_POSIX_VERSION		✅
_POSIX_ASYNCHRONOUS_IO	Not supported for now. return -1 / ENOTSUP	✅
_POSIX_BARRIERS		✅
_POSIX_CLOCK_SELECTION		✅
_POSIX_MAPPED_FILES	Need mmap(), munmap()	🟡
_POSIX_MEMORY_PROTECTION	Need mprotect()	🟡
_POSIX_READER_WRITER_LOCKS		✅
_POSIX_REALTIME_SIGNALS	Need sigqueue(), sigtimedwait(), sigwaitinfo() - in progress	✅

03 How it’s Going: Conformance: System Interfaces

_POSIX_SEMAPHORES		✅
_POSIX_SPIN_LOCKS		✅
_POSIX_THREAD_SAFE_FUNCTIONS	Low-hanging fruit - create a PR!	🟡
_POSIX_THREADS	Need pthread_kill() - last one 😁	✅
_POSIX_TIMEOUTS		✅
_POSIX_TIMERS		✅

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

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

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?

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/

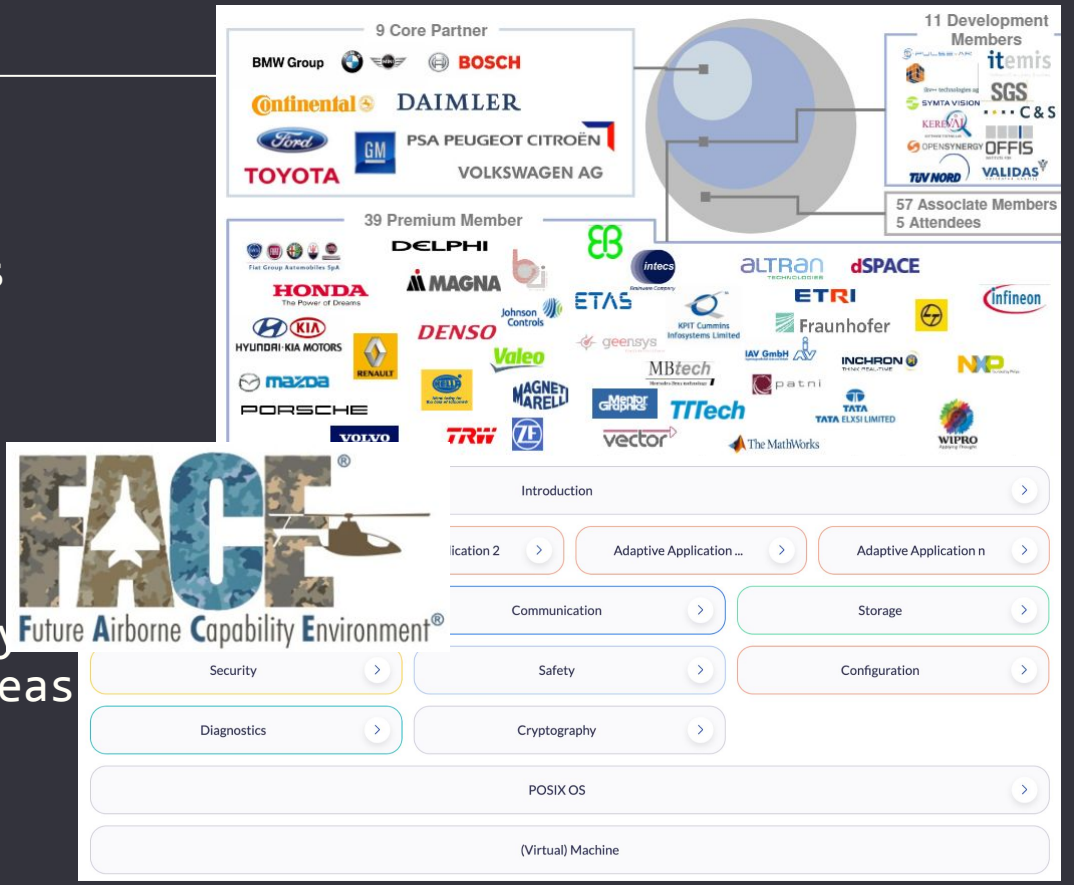
03 What next?

Safety Critical Applications

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

Some considerations..

- Companies want to certify Linux+Zephyr in these areas



https://www.vector.com/int/en/
https://www.autosar.org/standards/adaptive-platform
https://en.wikipedia.org/wiki/ARINC_653

04 What next?

Everyone Wants AI 🤖

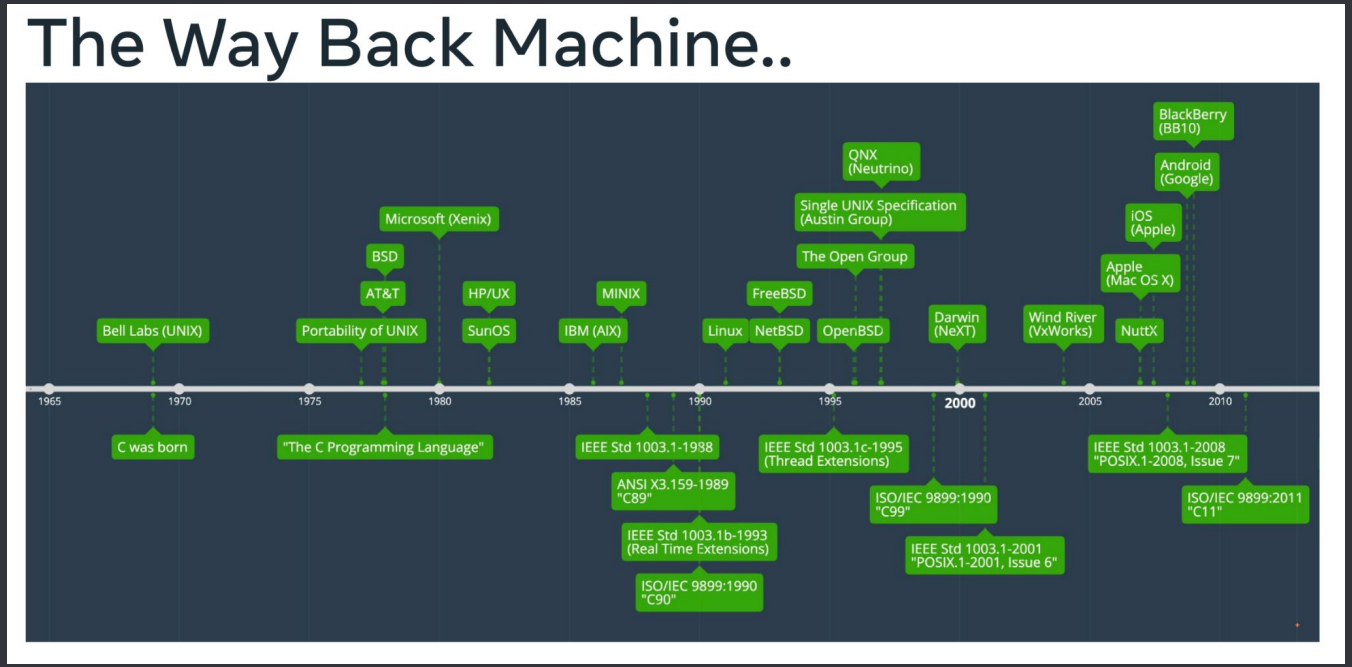
- Intelligent vehicles, Hyperscalar Infrastructure, Utilities, Mobile, Edge
- I know of a great AI Company
- Certification demands auditability

The future is Open Source

https://tenstorrent.com/cards/

Q/A

From EOSS 2023: UNIX turned 50 years old



From EOSS 2023

POSIX Turns 35 Years Old!