PERFORMANCE ANALYSIS USING NXP'S I.MX RT1050 CROSSOVER PROCESSOR AND THE ZEPHYR™ OS

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SECURE CONNECTIONS
FOR A SMARTER WORLD

PUBLIC

AGENDA

Zephyr Project introduction

Analysis scope

Hardware configuration

Benchmark study methodology

Run to run performance variation

Performance comparison with i.MX 6UL

Conclusions

Zephyr Project

Zephyr™

- Open source real time operating system
- Vibrant Community participation
- Built with safety and security in mind
- Cross-architecture with growing developer tool support
- Vendor Neutral governance
- Permissively licensed - Apache 2.0
- Complete, fully integrated, highly configurable, modular for flexibility, better than roll-your-own
- Product development ready with LTS
- Certification ready with Auditable

Why Zephyr?

The Zephyr OS addresses broad set of embedded use cases across a broad set of platforms and architectures using a modular and configurable infrastructure. It addresses the need for RTOS consolidation.

Address Fragmentation

- No single RTOS addresses broad set of embedded use cases across a broad set of platforms and architectures
- Disjoint use cases have led to fragmentation in RTOS space
- Existing commercial solutions force roll your own solutions and duplication of software components

Modular Infrastructure

- Modular and configurable infrastructure allows creation of highly compact and optimal solutions for different products from a common origin
- Reuse allows NRE costs to be amortized across multiple products and solutions
- Multi-architecture support reduces platform switching costs and vendor lock-in concerns

Open-Source

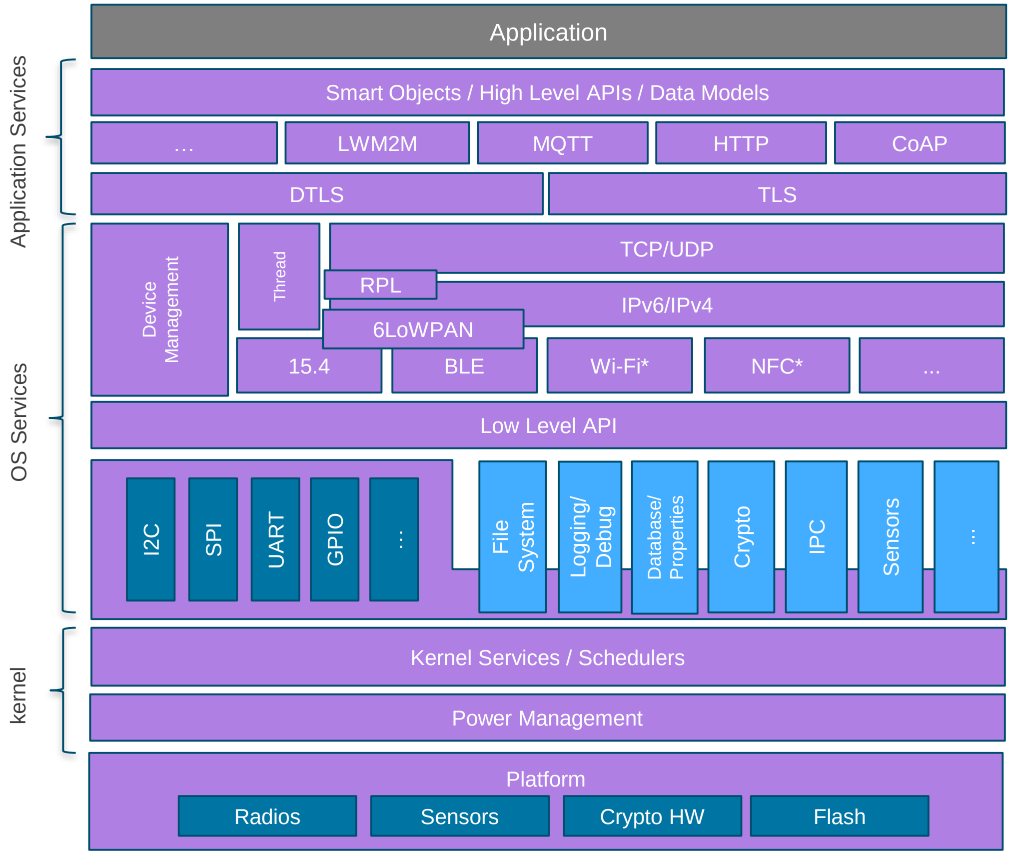
- Roll your own is expensive & difficult to develop & maintain
- Permissively licensed corresponds to ease of adoption
- Corporate sponsorship assures long term commitment and longevity
- Community innovation has proven faster for progression and project development is a collaboration of industry experts

Feature Richness

- Need for a solution or semi-complete solution rather than just an ingredient.
- Lowers entry level barrier for new products and speeds up software delivery using existing feature and hardware support
- Encourages adherence to standards and promotes collaboration on complex features inside the organization
- Developers focus on the end-user facing interfaces instead of re-inventing low level interfaces

Reduce costs and improve efficiency through reuse

Architecture



- Highly Configurable, Highly Modular
- Cooperative and Pre-emptive Threading
- Memory and Resources are typically statically allocated
- Integrated device driver interface
- Memory Protection: Stack overflow protection, Kernel object and device driver permission tracking, Thread isolation
- Bluetooth® Low Energy (BLE 4.2, 5.0) with both controller and host, BLE Mesh
- Native, fully featured and optimized networking stack

Fully featured OS allows developers to focus on the application

Analysis scope

Asses the real-time efficiency of an embedded system (i.MX RT1050 crossover processor)

Determine the performance gap between the MIMXRT1050-EVK board equipped with an embedded ARM SoC and a similar board equipped with an application processor.

Hardware configuration

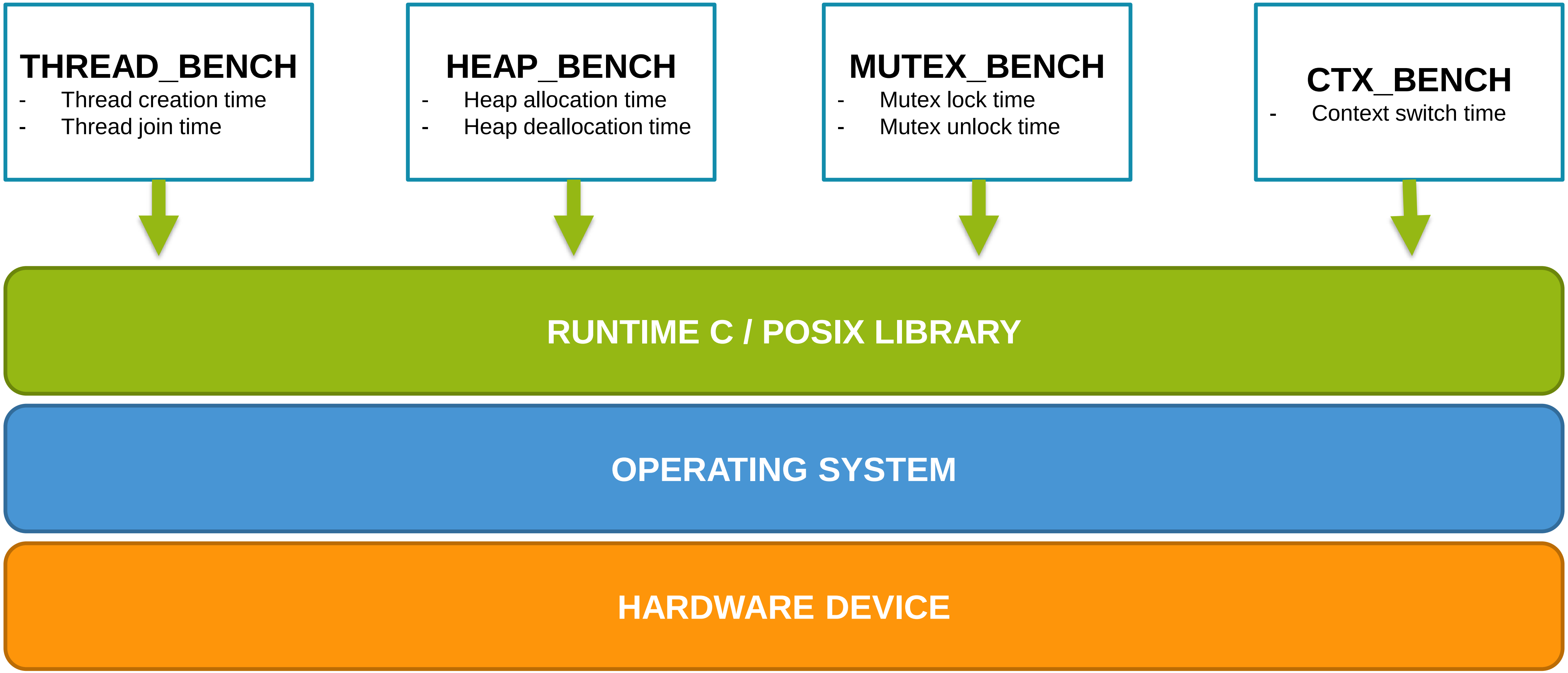
i.MX RT1050 configuration

- Development board: MIMXRT1050-EVK
- Processor: MIMXRT1052DVL6A Arm® Cortex®-M7 core
- Number of cores: 1
- Core Frequency: 600 MHz
- Board schematic: SCH-29538 REV A1
- OS name: Zephyr OS 1.11.99
- OS type: Real Time OS

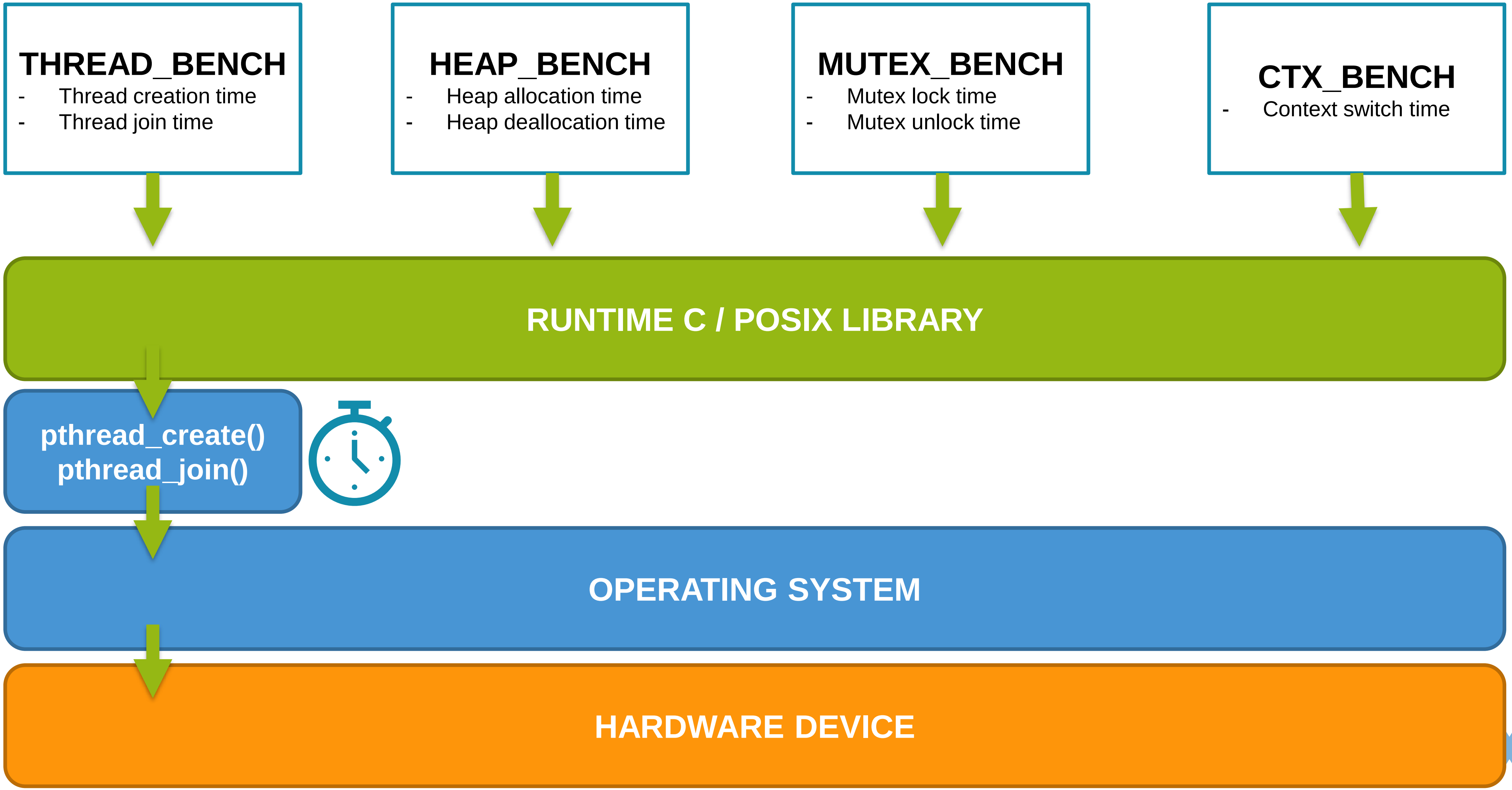
i.MX 6UL configuration

- Development board: i.MX 6UL EVK
- Processor: i.MX 6UltraLite Processor based on Arm Cortex-A7 core
- Number of cores: 1
- Core Frequency: 528 MHz
- Board schematic: SCH-29163 REV A2
- OS name: Linux BSP - kernel 4.9.88-imx_4.9.88_2.0.0_ga
- OS Type: Non- Real Time OS

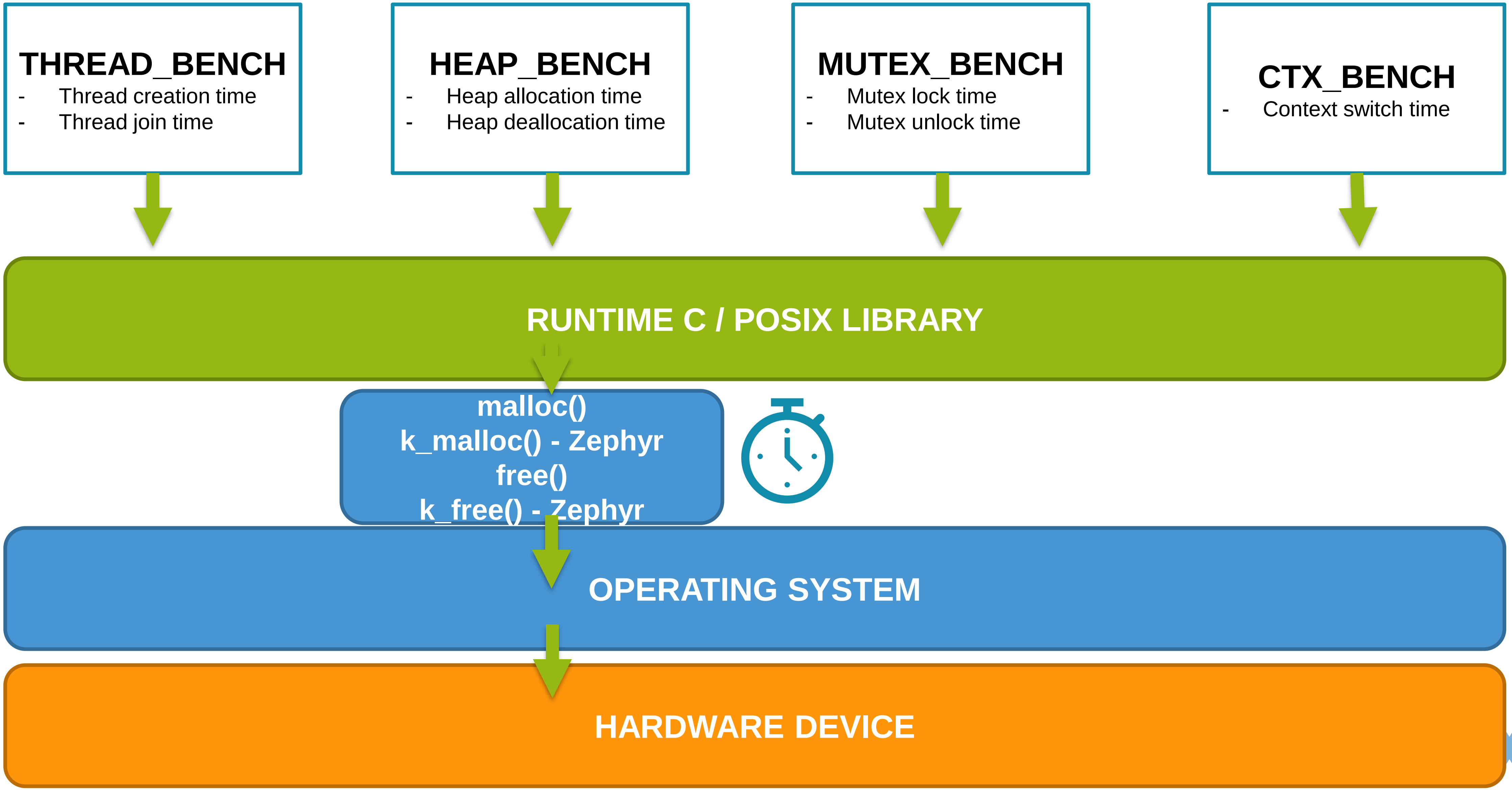
Benchmarking methodology



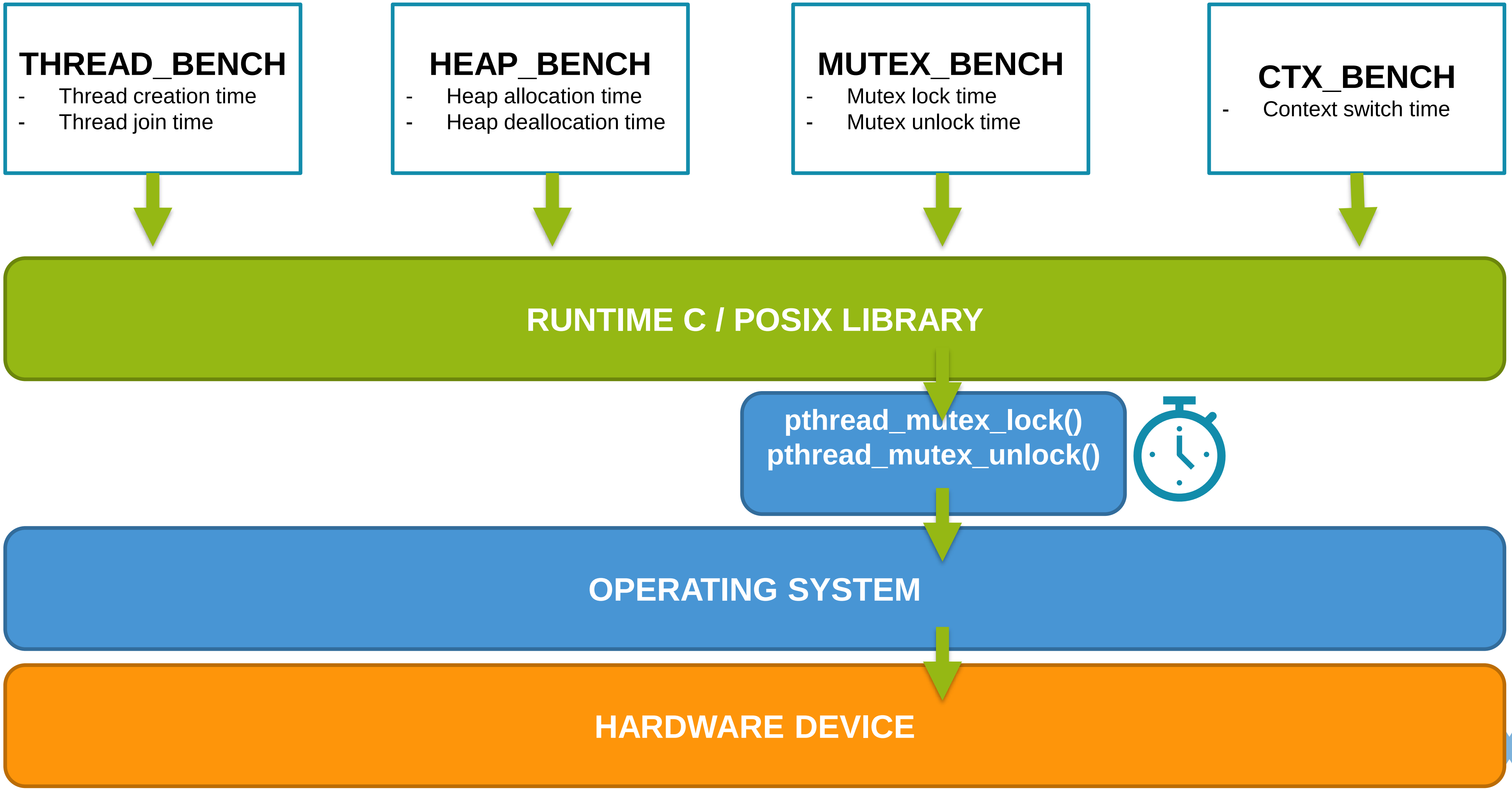
Benchmarking methodology



Benchmarking methodology



Benchmarking methodology



Benchmarking methodology

THREAD_BENCH
- Thread creation time
- Thread join time

HEAP_BENCH
- Heap allocation time
- Heap deallocation time

MUTEX_BENCH
- Mutex lock time
- Mutex unlock time

CTX_BENCH
- Context switch time

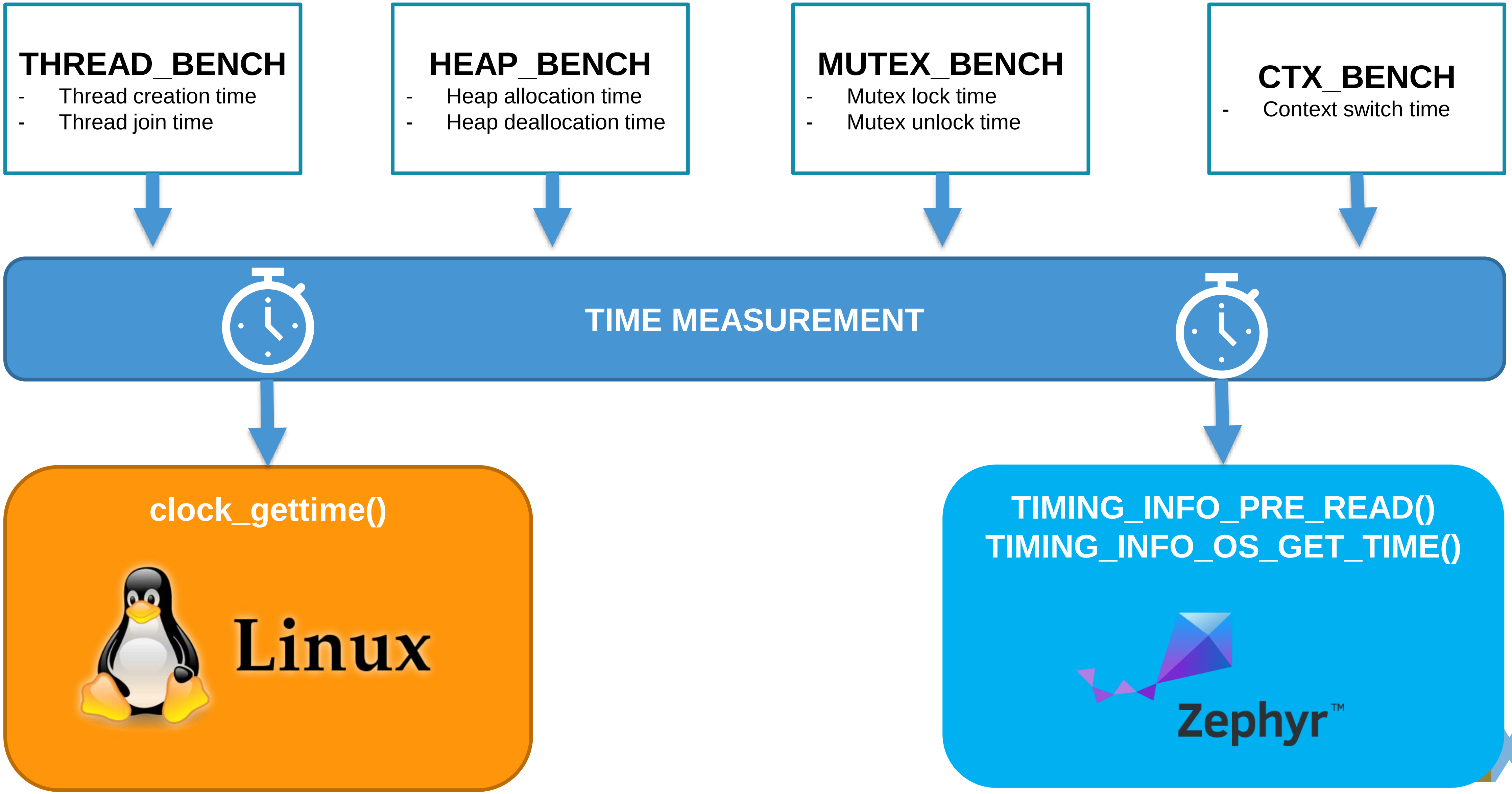
RUNTIME C / POSIX LIBRARY

sched_yield();
FUTEX / MUTEX

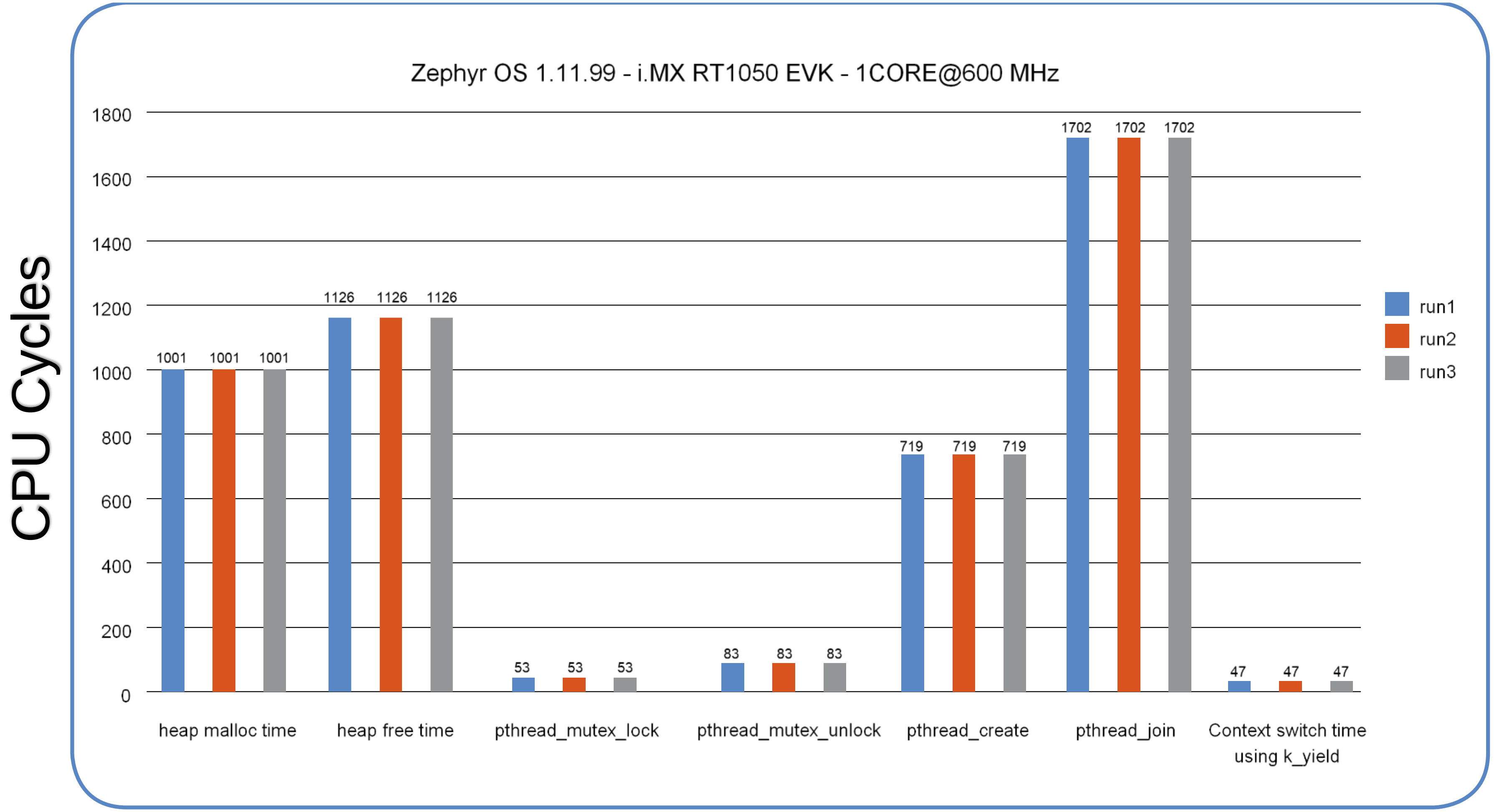
OPERATING SYSTEM

HARDWARE DEVICE

Benchmarking methodology



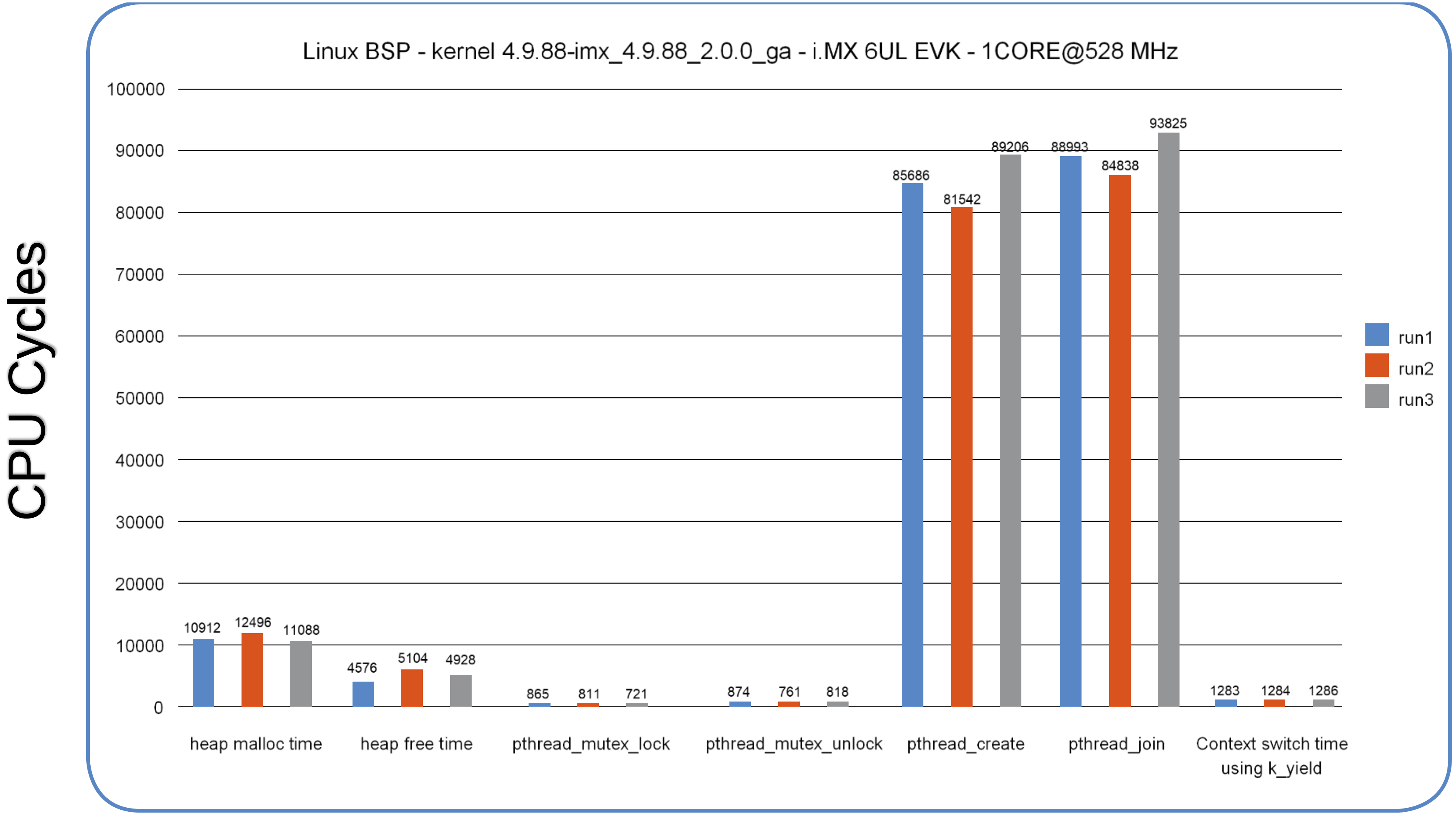
i.MX RT1050 EVK with Zephyr OS – Run to run variation



Predictable results observed. No variations from run to run.

TIMING_INFO_PRE_READ() used to record elapsed time.

i.MX 6UL EVK with Linux BSP – Run to run variation



Results varies from run to run, depending on what the OS is doing “behind the scenes”.

Used **clock_get_time()** to record the elapsed time.

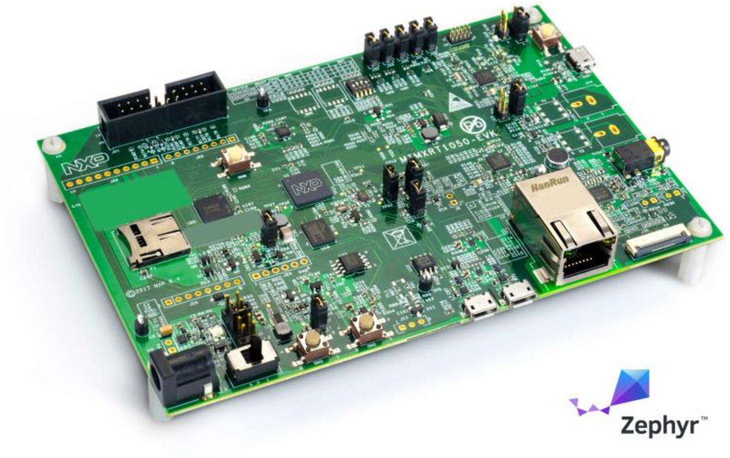
Performance comparison

OS	Zephyr OS 1.11.99	Linux BSP 4.9.88-imx_4.9.88_2.0.0_ga	Difference (x times)
Board Name	i.MX RT1050 EVK Arm® Cortex® M7	i.MX 6UL EVK Arm® Cortex® A7	-
CPU Cores	1	1	-
Core Frequency (MHz)	600	528	-
Average heap malloc time (cycles)	1001	11499	11x
Average heap free time (cycles)	1126	4870	4x
Average pthread_mutex_lock time (cycles)	53	799	15x
Average pthread_mutex_unlock time (cycles)	83	818	10x
Average pthread_create time (cycles)	719	85478	118x
Average pthread_join time (cycles)	1702	89219	52x
Average Context switch time (cycles)	47	1284	27x

The average time is calculated in cycles (lower is better).

Zephyr OS running on the i.MX RT1050 presents a significant improvement in all time cycles compared to the Linux BSP + i.MX 6UL EVK.

Conclusions



- The performance analysis was done by running custom microbenchmarks on two different hardware & software platforms.
- Benchmarks were developed around a common API to have comparable results.

i.MX RT1050 EVK with Zephyr OS performs significantly better than i.MX 6UL with Linux BSP when doing the same tasks.

NXP Platforms supported by Zephyr OS

NXP Boards

- MIMXRT1050-EVKB
- MIMXRT1060-EVK
- FRDM-K64F
- FRDM-KL25Z
- FRDM-KW41Z
- Hexiwear
- LPC54114 (M0 Core)
- LPC54114 (M4 Core)

- Partner boards:
  - UDOO Neo Full (with i.MX 6SoloX - Arm Cortex-M4 Core only)
  - Colibri iMX7 (i.MX7 SoC - Arm Cortex-M4 Core only)

www.nxp.com/zephyr

Thank You !