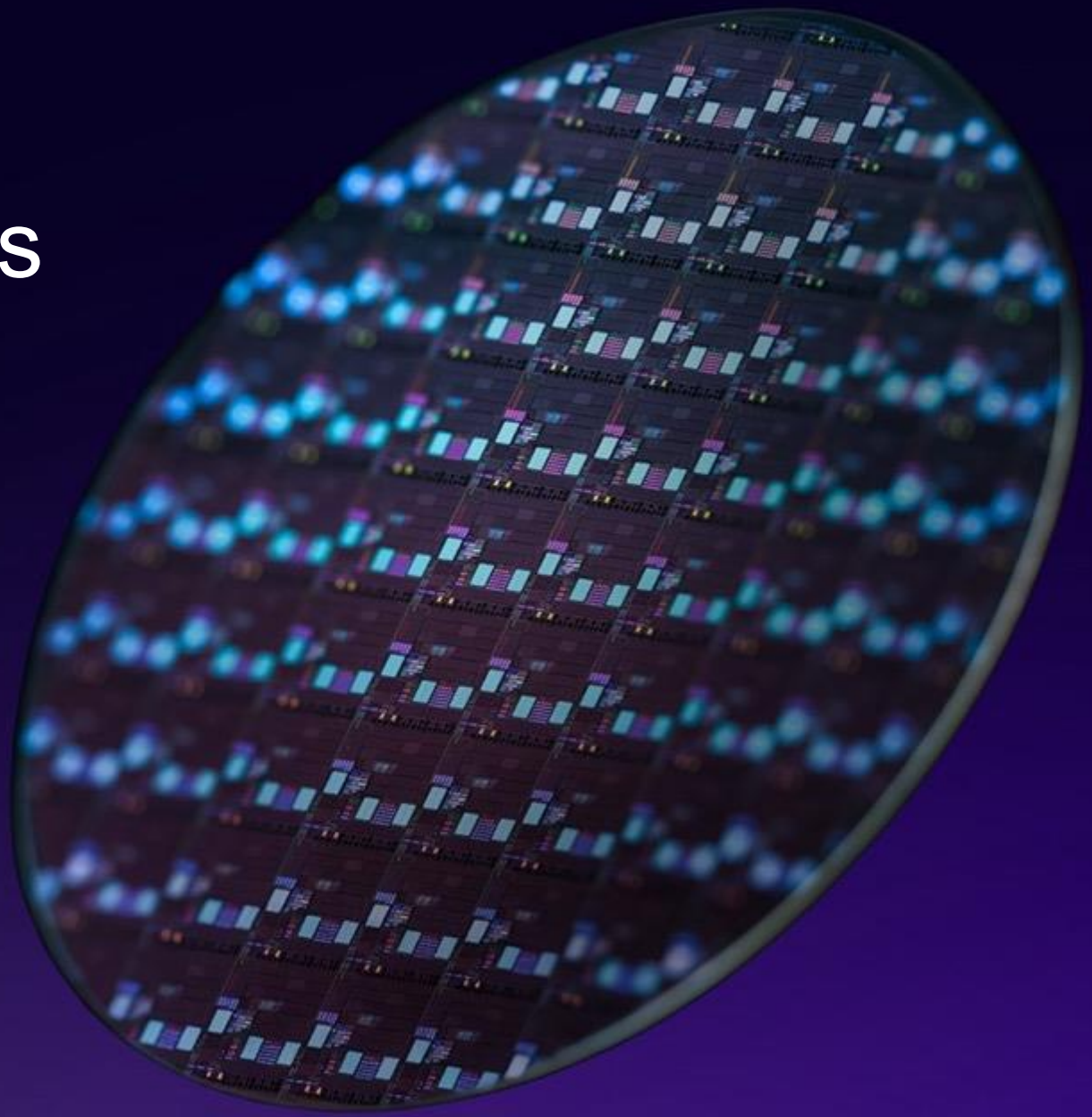
arm

Can LLVM-libc be used as the library for embedded toolchains?



William Huynh
15/09/25

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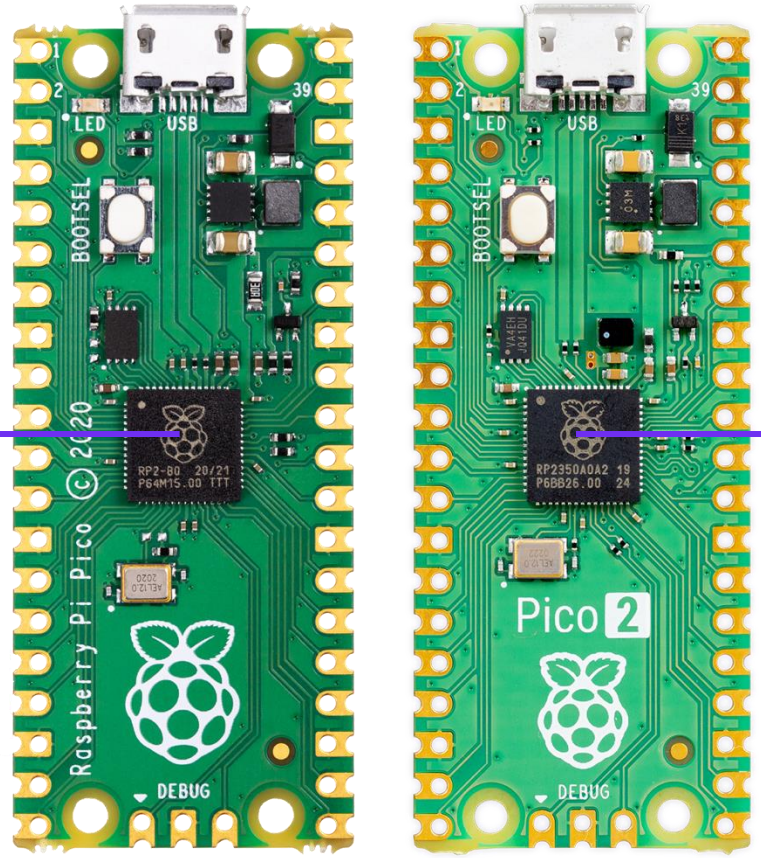
Background

We develop a toolchain for embedded Arm platforms

RP2040

Cortex-M0+

Arm v6-M



RP2350

Cortex-M33

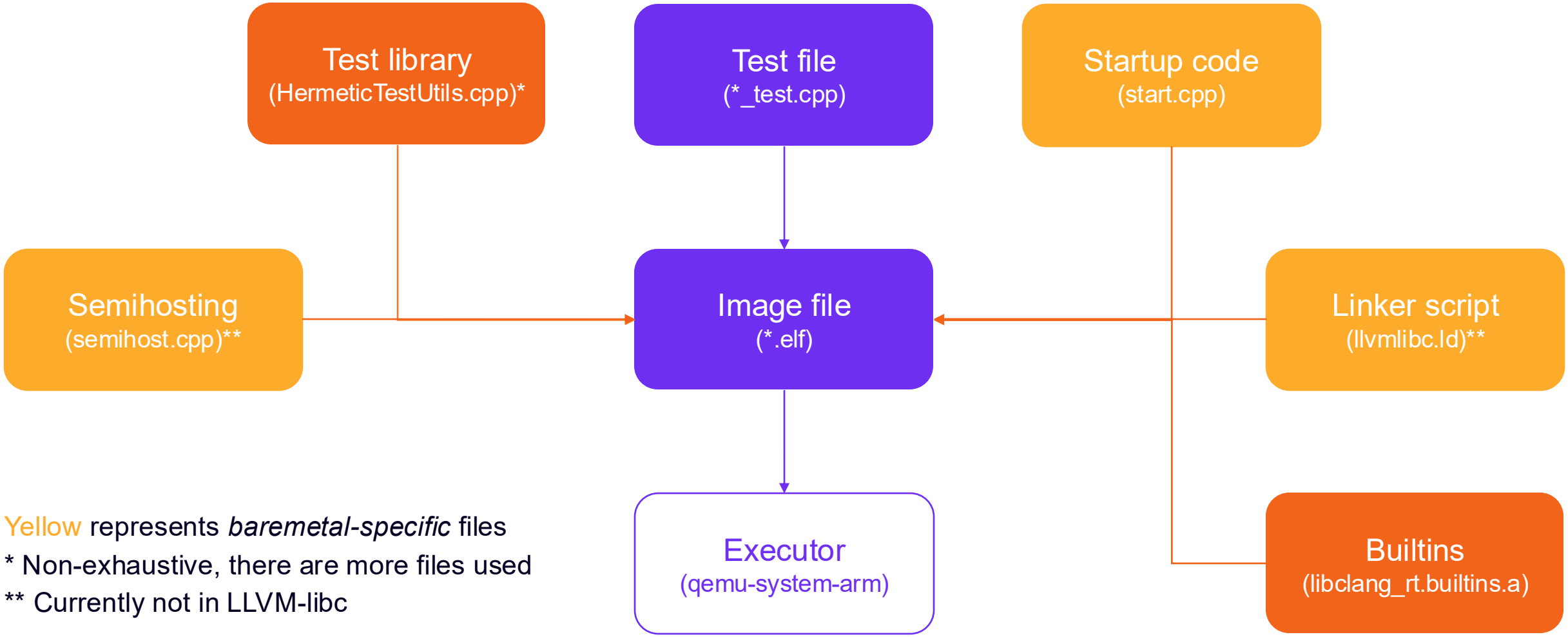
Arm v8-M

Current toolchain setup

Ideal toolchain setup

Is LLVM-libc correct and performant?

Basic testing setup for each (variant, test)



Yellow represents *baremetal-specific* files

* Non-exhaustive, there are more files used

** Currently not in LLVM-libc

Reference: https://github.com/arm/arm-toolchain/blob/arm-software/arm-software/embedded/arm-runtimes/CMakeLists.txt

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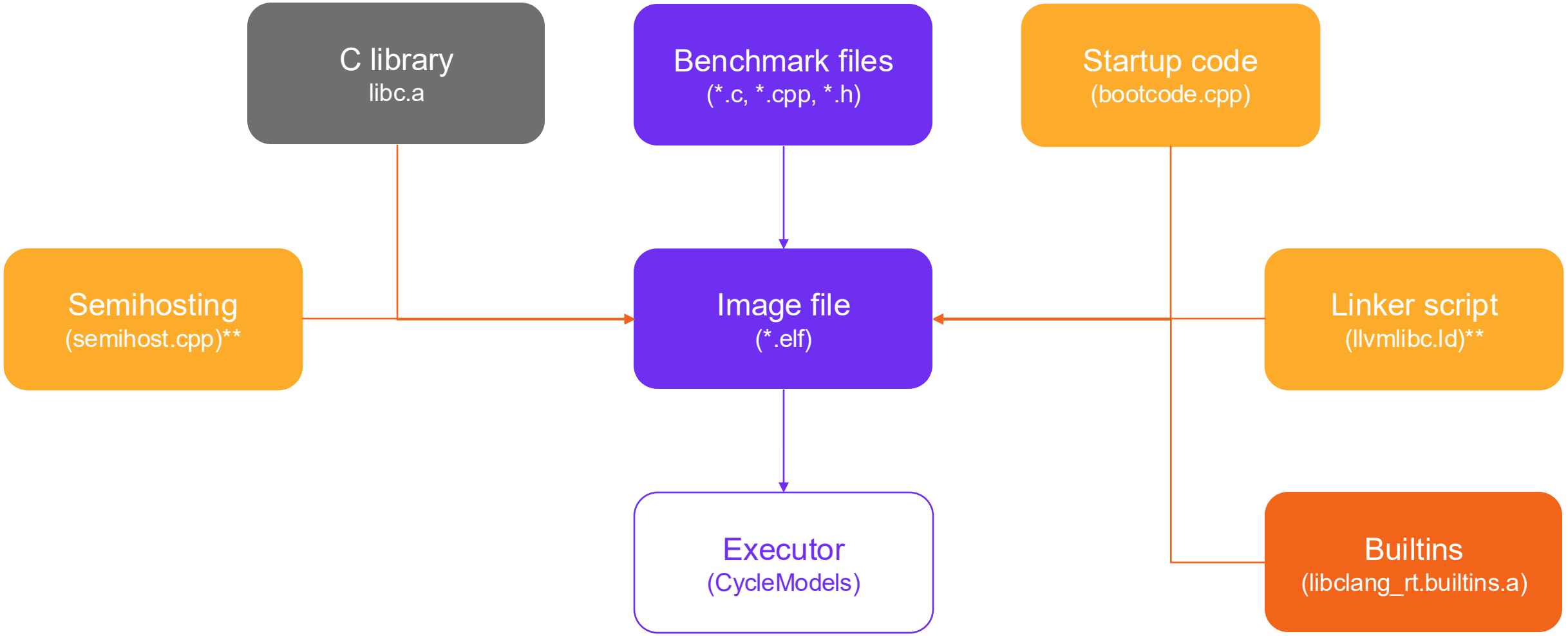
Testing in Action

- Looks identical to upstream tests but internally uses our setup.
- Passes most, but not all of the tests.

```
[1069/3255] Running hermetic test libc.test.src.math.ldexp_test.__hermetic__
[==========] Running 6 tests from 1 test suite.
[ RUN      ] LlvmLibcLdExpTest.SpecialNumbers
[       OK ] LlvmLibcLdExpTest.SpecialNumbers (0 ns)
[ RUN      ] LlvmLibcLdExpTest.PowersOfTwo
[       OK ] LlvmLibcLdExpTest.PowersOfTwo (0 ns)
[ RUN      ] LlvmLibcLdExpTest.OverFlow
[       OK ] LlvmLibcLdExpTest.OverFlow (0 ns)
[ RUN      ] LlvmLibcLdExpTest.UnderflowToZeroOnNormal
[       OK ] LlvmLibcLdExpTest.UnderflowToZeroOnNormal (0 ns)
[ RUN      ] LlvmLibcLdExpTest.UnderflowToZeroOnSubnormal
[       OK ] LlvmLibcLdExpTest.UnderflowToZeroOnSubnormal (0 ns)
[ RUN      ] LlvmLibcLdExpTest.NormalOperation
[       OK ] LlvmLibcLdExpTest.NormalOperation (10 ms)
Ran 6 tests.  PASS: 6  FAIL: 0
```

Reference: https://github.com/arm/arm-toolchain/actions/runs/18703574536/job/53336991030#step:9:1

Basic benchmarking setup for each variant



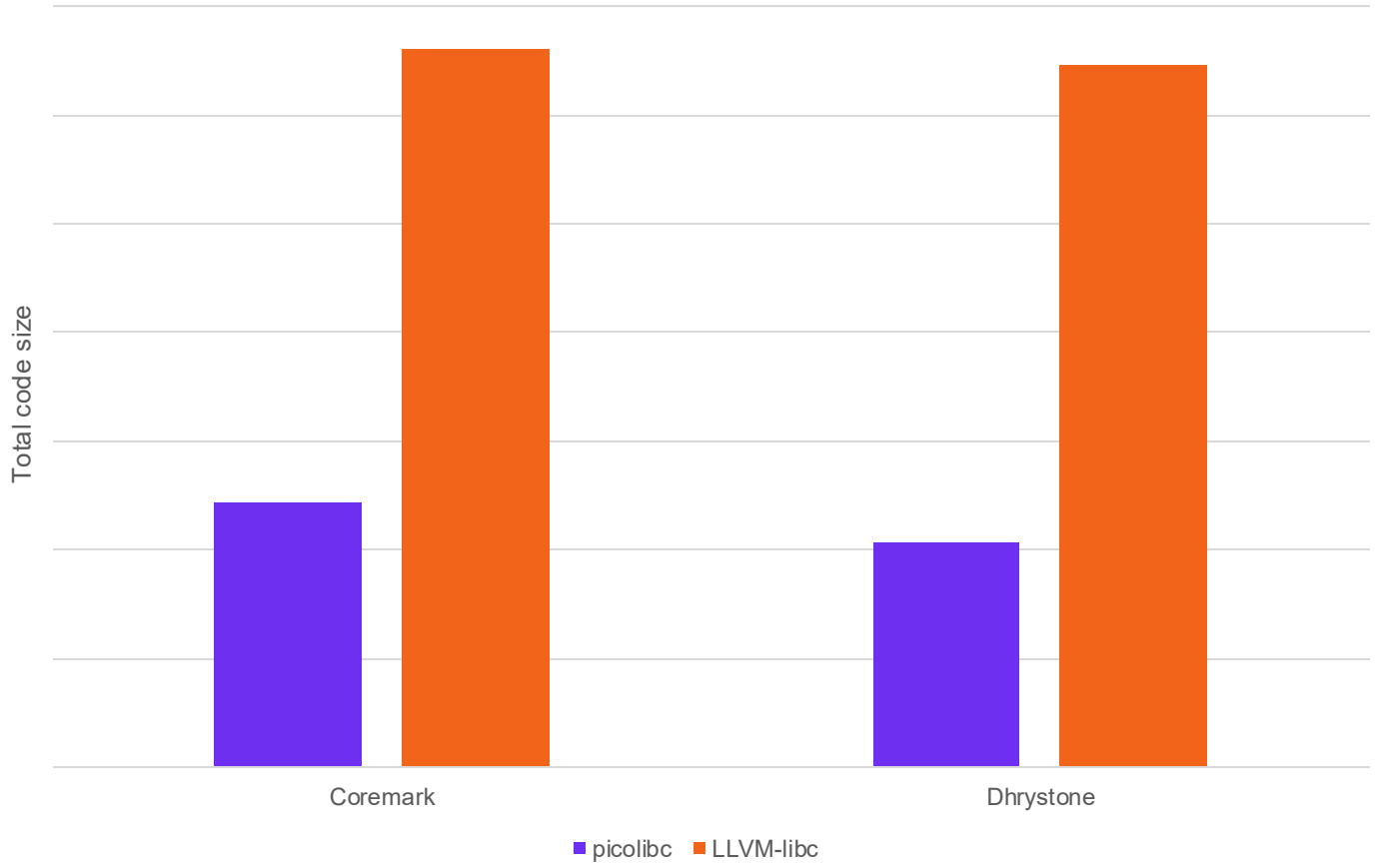
** Currently not in LLVM-libc

LLVM-libc vs picolibc

Tested on Cortex-M55 (v8.1-M), accurate as of 21/10/25

The figures look worse on code size…

We are seeing increased code size



Reference: https://discourse.llvm.org/t/rfc-printf-code-size-optimization/83146

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There is still a lot of work to do

References

- Toolchain: https://github.com/arm/arm-toolchain
- Tracking issue: https://github.com/llvm/llvm-project/issues/145349
- Inspired by: https://llvm.org/devmtg/2024-10/slides/techtalk/Hosek-ModernEmbeddedDevelopment-with-LLVM.pdf
- Introduction to LLVM-libc: https://libc.llvm.org/
- QEMU: https://www.qemu.org/docs/master/system/target-arm.html

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Merci
Danke
Gracias
Grazie
谢谢
ありがとう
Asante
Thank You
감사합니다
धन्यवाद
Kiitos
شكرًا
ধন্যবাদ
תודה
ధన్యవాదములు
Köszönöm