SFO17-409 TSC OSS Toolchain Discussion

David A Rusling
Ryan S. Arnold, Maxim Kuvyrkov

Overview

- Toolchain work in Linaro
  - GCC
    - ARM GNU funding to TCWG and the effect on Linaro TCWG's roadmap
    - Transition of GNU toolchain release to ARM in 2018 (august)
    - ARMv8.2
    - SVE upstream progress
      - GDB SVE enablement moving forward
  - LLVM
    - ARMv8.2
    - LLVM growth roadmap
    - SVE upstream progress
  - ILP32
    - ILP32 toolchain progress update
  - FDPIC Toolchain
- Discussion
  - Does this all fit together?
  - Is there anything that we're missing?

Key GNU Deliverables

1. TCWG-1232 Link Time Optimization tuning for AArch64
2. TCWG-64 Sign/Zero-Extension Elimination optimizations
3. TCWG-1233 Investigate scalability of libgomp on SPEC CPU2017
4. TCWG-1207 ILP32 Toolchain
5. TCWG-159 GDB Kernel Awareness
6. TCWG-1035 GDB target description rework for SVE enablement
7. TCWG-1160, TCWG-1161 OpenOCD AArch64 & GDB Remote debugging interoperability
8. TCWG-935 Automated regression testing of upstream branches
9. TCWG-1231 Automated benchmarking of upstream branches

ARM funding of GNU work & Need for LLVM

- High volume of LLVM work needed to be done (*see LLVM Growth Roadmap slides).* Linaro Exec Mgmt was planning to propose TCWG transition to LLVM in the future. This initial proposal was shared with ARM.
- ARM expressed concern as there is still important GNU work Linaro can do especially on behalf of ARM enterprise workloads.
- ARM has decided to fund three existing (full-time equivalent) TCWG engineers to continue to focus on GNU for at least the next year.
- Linaro is requesting additional LLVM engineers (assignees and / or member engineers) from membership

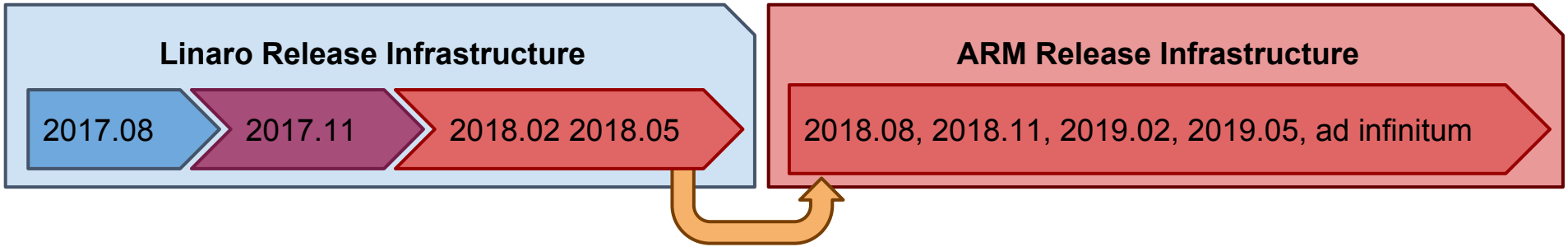
Impacts of ARM GNU Funding on TCWG

- Inevitability of Linaro TCWG transition to LLVM means ARM needs to eventually take over GNU Toolchain releases. This work will start immediately with a soft-transition.
- This will enable Linaro to focus more on upstream deliverables and to begin to transition more engineers toward LLVM development in the future.
- ARM will provide a reduced set of host-target combinations.
- Overlap between ARM customer interests and Linaro member interest is very high when it comes to toolchain.
  - The near term impact is ILP32 toolchain integration work being done to create a x86_64 to AArch64 ILP32 ‘snapshot’ cross toolchain.

Transition GNU Toolchain Releases to ARM

- ARM will commit two member engineers to take over the GNU Toolchain release process internally from Linaro employees and assignees in a soft-transition.
- ARM member engineers will start to implement release infrastructure within ARM for future releases.
- ARM will release GCC 7 (and the maintenance GCC 6 release) through August 2018 with Linaro's release infrastructure
- ARM will release GCC 8 (and the maintenance GCC 7 release) from ARM's release infrastructure starting August 2018

Toolchain Release Transition Schedule



- **GCC [6|7]-2017.08** - Linaro Employees/Assignees
  - ○Status quo process **With Linaro Infrastructure**
- **GCC [6|7]-2017.11** - Linaro Employees/Assignees with ARM Member Engineers
  - ○Transition to ARM MEs, using Linaro process **With Linaro Infrastructure**
- **GCC [6|7]-2018.02, 2018.05** - ARM Member Engineers
  - ○Training wheels off, using Linaro process **With Linaro Infrastructure**
- **GCC [7|8]-2018.08, 2018.11, 2019.02, 2019.05, ad infinitum** - ARM Engineers
  - ○All in-house in ARM, using ARM process **With ARM Infrastructure**

Key LLVM Deliverables

1. TCWG-1236 Fix LLD for Android
    a. TCWG-1210 Implement -fix-cortex-a53-843419 in lld
2. TCWG-1183 FreeBSD linking with LLD (patches in upstream review)
3. Continue work on GlobalISel
    a. TCWG-826 Implement GlobalISel support for AArch32
    b. TCWG-1235 Monitor and benchmark GlobalISel support for AArch64 from Apple
4. TCWG-1233 Investigate scalability of libomp on SPEC CPU2017
5. TCWG-244, TCWG-668, TCWG-953, TCWG-1112 AArch32 and AArch64 LLVM buildbot hosting and maintenance
6. TCWG-1083 AArch32 and AArch64 LLVM release management
7. TCWG-1156 Compiler-rt build-system improvements

LLVM Growth Roadmap - GlobalISel

- Support vector data types and operations in GlobalISel
- MIR: Well defined, machine IR, with generic and target specific instr/regs
- Add links to IR snippets in MIR
- Validate AArch64 GlobalISel at -O0 before turning on as default
- Support ARM, Thumb, AArch32, hard-float, soft-float and other combinations in ARM 32-bit GlobalIsel

LLVM Growth Roadmap - LLD

- Improve unit-testing and integration validation
- Benchmark link-time performance of AArch64 linker
- Enable LTO (Link Time Optimization)
- Features related to use as system linker in LLVM toolchain for Android
- Add missing linker script cases and command line options to ARM port.
- Add testing for embedded cases (v{6-8}M)
- Support Build Attributes for interoperability with ARM linker object files
- Support Big-Endian
- Comparing to Gold/BFD in linking time, binary sizes, performance

LLVM Growth Roadmap - Vectorisation

- Loop and Scalar (SuperWord Level) - Pass the Instruction object to all cost functions, so we can do peephole
- VPlan vectorization framework to replace monolithic loop and scalar vectorisers to improve Single legalisation/cost/transformation phase
- outerloop vectorisation - ARM has identified “unroll-and-jam” as beneficial to CoreMark
- outerloop vectorisation - HPC workloads often benefit from outer-loop vectorisation
- outerloop vectorisation - At least unrolling the inner loop could provide benefit

LLVM Growth Roadmap - Lib C++ (and friends)

- System-wide validation to guarantee interoperability with GNU libs (libgcc, glibc)
- Used in FreeBSD for years in x86_64, has troubles on ARM - address known deficiencies.
- Fix locale trouble on ARMv7
- Implement validation of Lib C++ (and friends) on AArch64

LLVM Growth Roadmap - Cross-Compilation

- Sysroot detection - Clang's header/lib/tools detection is based on poor heuristics
- Sysroot detection - Clang's triple/env detection is based on poor heuristics
- Sysroot detection - Clang still defaults to "system header/lib/linker" on failure
- GNU compatibility - Most tests still rely on glibc, libgcc, binutils, but we can't easily change versions (without changing the host's OS)
- We should have cross-builds like GCC, we could start with QEMU

LLVM Growth Roadmap - Target Parser

- Most of the knowledge is duplicated in TableGen Our target descriptions already have most of it, adding the rest would be simple
- Create a new TableGen backend to produce the “string-tables”
- Logic is duplicated between ARM and AArch64, design a “static class design” or investigate other alternatives
- Merge target parser with Triple library - Triple class has some redundant logic/knowledge
- Remove all parsing of architectural strings, even from Triple

LLVM Growth Roadmap - LLVM Bugs

- Address existing bug backlog for AArch64 GlobalISel
- Address existing bug backlog for Chromium
- Address existing bug backlog for Android
- Address existing bug backlog for Linux/FreeBSD bugs

LLVM Growth Roadmap - Scheduler

- Overall improvement to generic ARM/AArch64 scheduler - completeness and accuracy.

LLVM Growth Roadmap - Target Descriptor

- "Cleanup targets have “features” which are usually abused for scheduling/isel poor choices
- We still have some “isLikeA9()” functions which are nothing “like A9” behaviour"
- Document target description strategies and best-practices

LLVM Growth Roadmap - Test-suite / Benchmarks

- Some tests are redundant, some are obsolete, needs a cleanup
- Some benchmarks are badly prepared/executed
- Would be nice to have more modern/HPC tests/benchmarks

LLVM Growth Roadmap - Benchmarking

- Comparing to GCC on ARM
- Comparing to LLVM on x86_64
- We need at least a monthly CI on LLVM for SPEC/EEMBC/HPC
- Address open performance analysis tasks in Linaro backlog

LLVM Growth Roadmap - Performance

- Address found performance analysis issues found in benchmarking tasks.

LLVM Growth Roadmap - Debug info enhancement

- fixing missing or wrong debug info for non-O0 optimization
- Improve debugging experience when debugging application with optimization

LLVM Growth Roadmap - Move the content of SLEEF into LLVM/parallel-libs

- http://github.com/shibatch/sleef , a target-independent library for vector math routines, with target-specific implementations
- The parallel-libs does not allow direct contribution from ARM, but the author of SLEEF has granted permission for SLEEF code to be ported to parallel-libs (http://lists.llvm.org/pipermail/llvm-dev/2016-July/102254.html)
  - Note that some of the non-ARM side of this work has already been started (https://reviews.llvm.org/D24951). Note also that ARM have a downstream implementation of SLEEF targeting SVE

LLVM Growth Roadmap - LoopVector Analysis

- Refactor LoopVectorAnalysis into a separate pass
  - Limited immediate benefit to the community, but helps future development of the vectorizer

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TCWG preview-grade ILP32 toolchain

- Same process as for release-grade cross-toolchains
  - Automated build and test harness
  - Quarterly cadence
  - Hosted on x86_64-linux, i686-linux and i686-mingw
- Same components as in release toolchains
  - GCC 7.1, Binutils 2.28, GDB 8.0
- Community-supported branches for ILP32
  - Linux kernel: staging/ilp32-4.12
  - Glibc: arm/ilp32
- First upload
  - https://snapshots.linaro.org/components/toolchain/binaries/7.1-2017.08-rc1/aarch64-linux-gnu_ilp32/
- Next update in November 2017

Known ILP32 toolchain issues

- Status for 7.1-2017.08-rc1 upload
- Sanitizer support (ASAN, UBSAN, etc.)
  - Need porting to ILP32
  - Sanitizers do not build for ILP32
  - TCWG plans to estimate effort size on sanitizers, and, potentially, port them to ILP32
- Compiler testsuite failures
  - There are several dozen of failures compared to AArch64 LP64
  - TCWG will investigate and fix or file bugs upstream
- LTP failures in get*ent tests
  - Seems like a patch is missing on glibc/arm/ilp32 branch
  - Should be fixed in next upload

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ILP32 Linux kernel branches

- ILP32 ABI is stable and will not change
  - Unless highly critical ABI problem is found

- Linux kernel ILP32 staging branches
  - git://git.kernel.org/pub/scm/linux/kernel/git/arm64/linux.git
  - staging/ilp32-4.12
  - staging/ilp32-4.13
- ARM64 kernel maintainer evaluates ILP32 adoption
  - every 6 months
- ILP32 Linux branch is planned to be either merged or abandoned within 2 years

ILP32 glibc branch

- ILP32 ABI is stable and will not change
  - Unless highly critical ABI problem is found
- Glibc ILP32 staging branch
  - https://sourceware.org/git/?p=glibc.git;a=shortlog;h=refs/heads/arm/ilp32
  - arm/ilp32
- Glibc will merge ILP32 branch once kernel branch is merged
- Merging Glibc branch will NOT break compatibility
  - Symbol versions will not be updated

OpenEmbedded ILP32 Status

- https://projects.linaro.org/browse/CTT-405
- Minimal-ltp images for generic-armv8 target is available
  - http://snapshots.linaro.org/openembedded/images/minimal-ltp-armv8-ilp32-gcc-7.1/12/
- The rootfs has been validated on HiKey with upstream kernel
  - https://git.kernel.org/pub/scm/linux/kernel/git/arm64/linux.git/log/?h=staging/ilp32-4.12
- Important packages are part of the image
  - Glibc-2.25

Debian ILP32 Bootstrap

- https://projects.linaro.org/browse/CTT-157
- Task to produce debootstrapable rootfs
- Current focus on debian stable to avoid moving-target hassles. Using ‘rebootstrap’ script for repeatable bootstrapping.
- All using updated triplet: aarch64-linux-gnu_ilp32
- Repo of aptable packages at http://people.linaro.org/~wookey/ilp32/repo/
- Port status page: https://wiki.debian.org/Arm64ilp32Port
- Toolchains: debian-stable multiarch cross-toolchains for amd64 and arm64 in above repo. GCC-6, glibc2.24 based.

Debian ILP32 Bootstrap - 2

- Base packages: 141 out of 144 packages built. Almost enough to debootstrap filesystem.
- Patches for dpkg, binutils, gcc-6, glibc, linux, libatomic-ops, openssl, libgpg-error, gmp, nspr, libgc, findutils, gnutls28, systemd, libssh2, openssl1.0, curl, perl.
- Git repo containing patches at:
  https://anonscm.debian.org/cgit/users/wookey/rebootstrap.git
  Branches for stable and unstable.
- Bootstrap works exactly as well on arm64 build hardware as it does on amd64, which is nice.

FDPIC Toolchain

- FDPIC allows to use shared libraries on MMU-less systems
- Linux kernel patches for no-MMU are expected to land in 4.14
- GCC 4.7-based FDPIC toolchain by ST
  - https://github.com/mickael-guene/fdpic_manifest
  - Not upstreamed

- Should TCWG update and upstream GNU support for FDPIC?
- Should TCWG develop and upstream LLVM support for FDPIC?

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Thank You

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