Release Note for Arm Instruction Emulator

22.0

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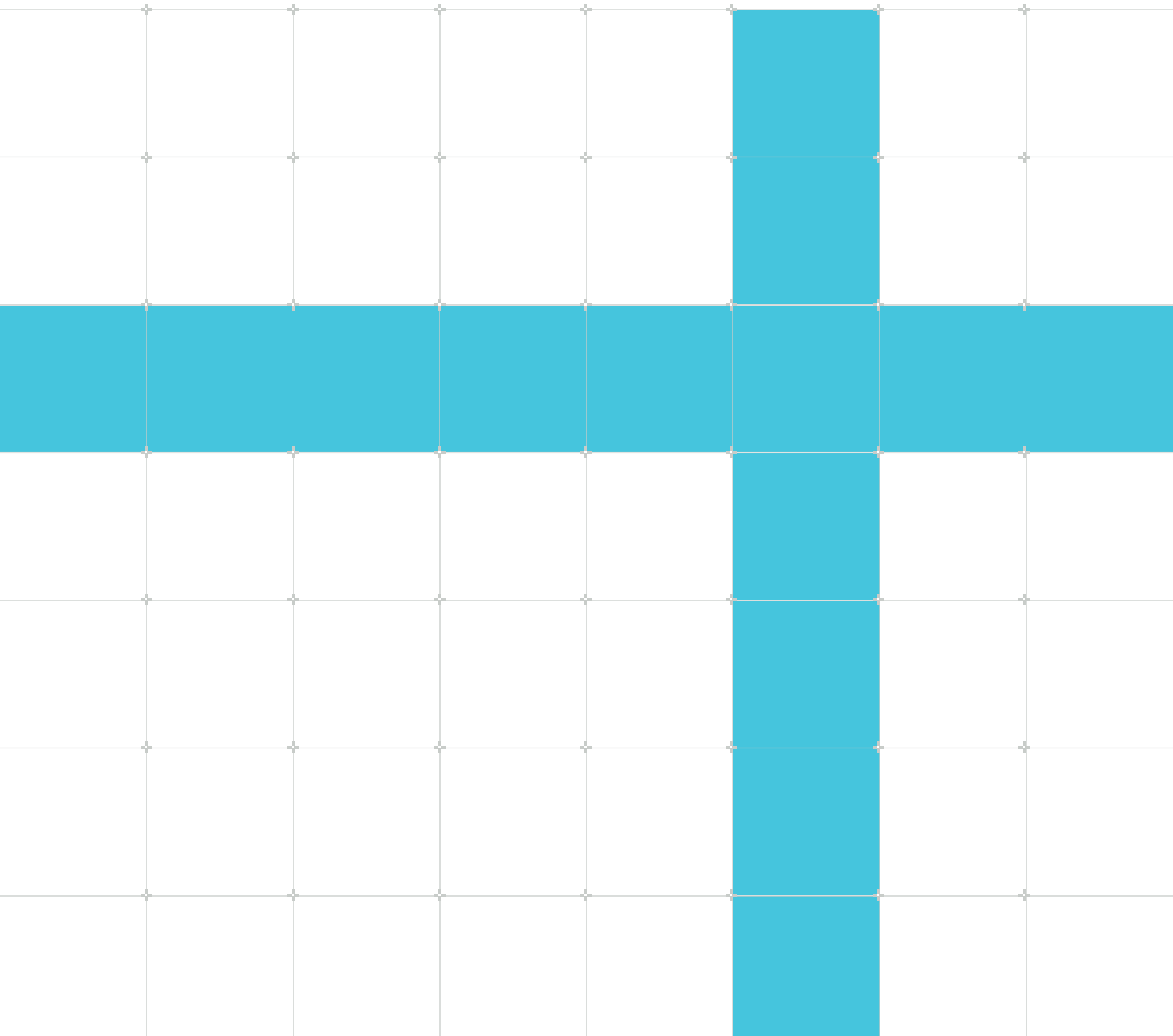

Release Note for Arm Instruction Emulator

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Release information

Document history

Issue	Date	Confidentiality	Change
1800-01	28 March 2018	Non-Confidential	18.0 release
1801-01	30 April 2018	Non-Confidential	18.1 release
1802-01	24 August 2018	Non-Confidential	18.2 release
1803-01	5 October 2018	Non-Confidential	18.3 release
1804-01	2 November 2018	Non-Confidential	18.4 release
1900-01	5 April 2019	Non-Confidential	19.0 release
1901-01	3 July 2019	Non-Confidential	19.1 release
1902-01	30 August 2019	Non-Confidential	19.2 release
2000-01	18 February 2020	Non-Confidential	20.0 release
2001-01	21 August 2020	Non-Confidential	20.1 release
2100-01	30 March 2021	Non-Confidential	21.0 release
2200-01	31 March 2022	Non-Confidential	22.0 release

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Contents

This release contains the following sections:

- Release overview
- Release contents
- Get started
- Support
- Release history
- Glossary
- Proprietary notices

Release overview

Product description

The Arm Instruction Emulator (ArmIE) allows users to emulate Scalable Vector Extension (SVE and SVE2) instructions on AArch64 hardware. ArmIE also includes features for instrumenting AArch64 and SVE instructions.

Note: On some Arm-based hardware, some Armv8.2 and Armv8.3 AArch64 instructions can also be emulated.

ArmIE is based on the Open Source DynamoRIO dynamic binary instrumentation platform http://www.dynamorio.org/home.html. The DynamoRIO API has been augmented with an emulation interface which allows run-time analysis of SVE binaries using the existing DynamoRIO instrumentation capabilities. Examples are provided to help users develop their own instrumentation clients.

Release status

This is the 22.0 release of Arm Instruction Emulator.

These deliverables are being released under the terms of the agreement between Arm and each licensee (the “Agreement”).

All planned verification and validation is complete. The release is suitable for volume production under the terms of the Agreement.

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Release contents

The following subsections detail:

- The component parts that are delivered as part of this release.
- Any changes since the previous release.
- Any known issues and limitations that exist at the time of this release.

Deliverables

- Arm Instruction Emulator 22.0
- Release Notes (this document, also available at: https://developer.arm.com/tools-and-software/server-and-hpc/compile/arm-instruction-emulator/get-software/download/release-history)
- The Arm Instruction Emulator Developer and Reference guide is available on the Arm Developer website at: https://developer.arm.com/documentation/102190/22-0

Information about how to use the Arm Instruction Emulator to emulate Scalable Vector Extension (SVE) and SVE2 instructions on AArch64 platforms is available on the Arm Developer website at: https://developer.arm.com/tools-and-software/server-and-hpc/compile/arm-instruction-emulator/

Further documentation about all Arm HPC tools can be found online at: https://developer.arm.com/tools-and-software/server-and-hpc/help

Documentation can change between product releases. For the latest product documentation, check the software downloads page on the Arm Developer website at: https://developer.arm.com/tools-and-software/server-and-hpc/compile/arm-instruction-emulator/get-software/download/

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Differences from previous release

Differences from the previous release of Arm Instruction Emulator are detailed in the following subsections.

Additions and changes

- New license issued with this release that has no expiration date.
- Updated GCC runtime support from GCC 10.2 to GCC 11.2.

Resolved issues

- None in this release.

Deprecated features

The following features have been deprecated in this release, and might be removed in a future version:

- None in this release.

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Known limitations

There are DynamoRIO defects and issues logged at https://github.com/DynamoRIO/dynamorio/issues which might result in instrumentation and emulation failures.

Note: Thorough testing and validation of this release has not resulted in any bugs related to those issues.

There is a known DynamoRIO issue which causes hangs on some AArch64 hardware: https://github.com/DynamoRIO/dynamorio/issues/1698

ArmIE has a workaround for this using the `--unsafe-ldstex` option. This feature is enabled by default and has now been deprecated. It will be removed in a future release.

Get started

This section describes how to get started with Arm Instruction Emulator.

For more information, see: https://developer.arm.com/documentation/102190/22-0/Get-started

Licensing information

Arm Instruction Emulator 22.0 includes a time-unlimited license which is installed with the product.

Download the product

Arm delivers the files through the Arm Developer website:

https://developer.arm.com/tools-and-software/server-and-hpc/compile/arm-instruction-emulator/get-software/download

Unpack the product

The following steps describe how to unpack each constituent part delivered in this bundle:

1. Relocate the bundle file. Move the `.tar` files to the directory in which you want to install the product.
2. Extract the tar file contents using a tar utility:

```
tar -xvzf <package_name>.tar.gz
```

Directory structure

Shows the principal directory structure of this release created after unpacking the bundle:

```
license_terms/
arm-instruction-emulator-22.0*.sh
RELEASE_NOTES.txt
```

Install the product

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To install Arm Instruction Emulator, run the installation script as a privileged user and pass any options to configure the installation:

```
./arm-instruction-emulator-22.0*.sh <option> <option>
```

Some common installation options are:

- For a headless installation and to automatically accept the EULA, use the `--accept` option.
- To perform a local install, use the `--install-to <dir>` option.

The installer displays the EULA and prompts you to agree to the terms. If you agree, type 'yes' at the prompt to continue.

All the packages are unpacked to `<install_location>/<package_name>` with environment modulefiles available under `<install_location>/modulefiles`. The default installation location is `/opt/arm/`. Local installs have the same directory structure starting from your chosen installation root.

If, after installation, you decide not to agree to the terms of the EULA, you must not run the emulator and you should delete all the installed files as described in 'Uninstalling' below.

See also the product installation instructions in the documentation at: https://developer.arm.com/documentation/102190/22-0/Get-started/Install-Arm-Instruction-Emulator.

Run the product

Note: Ensure that you have a pre-compiled binary to emulate with ArmIE.

1. Load the ArmIE environment module:

   ```
   module load armie22/22.0
   ```

2. Run the binary with Arm Instruction Emulator using one of these methods:
   - Invoke Arm Instruction Emulator and specify the vector length to use:

     ```
     armie -msve-vector-bits=<length> ./<binary>
     ```

   - Invoke Arm Instruction Emulator with an instrumentation (`-i`) or emulation (`-e`) client, and specify the vector length to use:

     ```
     armie -msve-vector-bits=<length> -e <emulation_client> -i
       <instrumentation_client> -- ./<binary>
     ```

     Instrumentation and emulation clients enable you to extract data on the execution of your binary.

Examples

See worked examples provided in the `README.txt` file supplied with this release.

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Uninstall

For convenience, this package includes an `uninstall.sh` script at:

```
<install_location>/arm-instruction-emulator-22.0*/uninstall.sh
```

This script uninstalls all the components supplied as part of Arm Instruction Emulator. When other packages outside of this product depend on the GNU GCC component, GNU GCC is not uninstalled.

If you require support when uninstalling any version of Arm Instruction Emulator, contact support-hpc-sw@arm.com.

Support

If you have any issues with the installation, content, or use of this release, please create a ticket on https://developer.arm.com/support. Arm will respond as soon as possible.

These deliverables are being released under the terms of the agreement between Arm and each licensee (the “Agreement”). All planned verification and validation is complete. The release is suitable for volume production under the terms of the Agreement.

Note: Support for this release of the product is only provided by Arm to partners who have a current support and maintenance contract for the product.

Supported platforms

Arm Instruction Emulator (ArmIE) version 22.0 is supported on the following Linux platforms:

- AArch64 Red Hat Enterprise Linux (RHEL) version 8 (Up to version 8.3).
- AArch64 SUSE Linux Enterprise Server (SLES) 15.
- AArch64 Ubuntu 18.04.

ArmIE is not supported on the following platform:

- Red Hat Linux Enterprise Linux version 8.4 and later.

Release history

A full release history for Arm Instruction Emulator is also available at: https://developer.arm.com/tools-and-software/server-and-hpc/compile/arm-instruction-emulator/get-software/download/release-history

Changes in Release 22.0

Removed Features

- None

New Features and Enhancements

- Updated GCC runtime support from GCC 10.2 to GCC 11.2.

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Bug Fixes

- None

Other Changes

- The license that is included in ArmIE 22.0 is no longer set to expire.

Changes in Release 21.0

Removed Features

- None

New Features and Enhancements

- Added support for the following v8.2 instructions, based on detection of hardware capability at startup:
  - Scalar half-precision variants of ucvtf and scvtf.
  - Half-precision fabd.
- Updated GCC runtime support from GCC 9.2 to GCC 10.2.

Bug Fixes

- Fixed some hardware feature checks for v8.2 and v8.3 emulation.
- Fixed a v8.3 fcmla emulation error.

Other Changes

- The license that is included in ArmIE 21.0 is set to expire after 31st March 2022.

Changes in Release 20.1

Removed Features

- None

New Features and Enhancements

- Added support for the following v8.2 instructions based on detection of hardware capability at startup: fmov, scvtf, frecpe, fabs, fcmgtz, fcvtzs, frintn, frsqrte, frsqrts, fmax, fmaxp and fdiv, scvtf, ucvtf

Bug Fixes

- Some SVE2 instructions that were not being emulated correctly have been fixed.
- CAS-164399-V9L7T0

  Output from the `-s` option now shows double-quoted client parameter strings correctly.

Other Changes

- The license that is included in ArmIE 20.1 is set to expire after 31st August 2021.

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Changes in Release 20.0

Removed Features

- The `--unsafe-ldstex` has been deprecated and is enabled by default. A new option, `--safe-ldstex`, has been added in the unlikely event that `--unsafe-ldstex` needs to be disabled.

New Features and Enhancements

- Added command option `--safe-ldstex`, (see 'Removed Features' above).
- Added support for the emulated v8.2 instructions: frsqrte, frsqrts, fmax, fmaxp and fdiv. Optimization of emulated v8.2 instructions: fmax and fma.
- Adds support for the full diagnostic reporting of illegal instructions (SIGILL), in other words, displaying the illegal encoding and its subject binary PC address.
- Added armie command line option, `--arg-iclient`, to enable the passing of arguments to instrumentation clients.
- Consistency updates to Region-of-Interest (ROI) feature, originally extended from memory tracing instrumentation client to instruction counting, opcode counting, and instruction tracing clients.
- Added an example of using Region-of-Interest (ROI) macros in Fortran source code in the `samples/fortran_roi` directory.
- Updated GCC linker/loader support from GCC 8.2 to GCC 9.2.

Bug Fixes

- Critical bug fix for OpenMPI applications.
- Improved installation compatibility with Arm Compiler for Linux and Arm Performance Libraries. This fixes a bug which required users to load the ArmIE environment module before loading the Arm Compiler for Linux and Arm Performance Libraries environment module.

Other Changes

- License is set to expire after 31st January 2021.

Changes in Release 19.2

Removed Features

- None.

New Features and Enhancements

- Emulation of the following v8.2 and v8.3 instructions based on detection of hardware capability at startup:

  v8.2 half-precision instructions: fadd, fsub, fmul, fmul (by element), fmla, fmla (by element), fmadd, fmsub, fmls, fmls (by element), fneg, fcmp.

  v8.3: fcmla, fcadd
- Upgraded to be compatible with GCC 8.2 linker/loader, (from GCC 7.1).

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Bug Fixes

- None.

Other Changes

- License set to expire after 31st August 2020.

Changes in Release 19.1

Removed Features

- None.

New Features and Enhancements

- Addition of an `uninstall.sh` script

Bug Fixes

- None.

Other Changes

- License extended to 31st March 2021.

Changes in Release 19.0

Removed Features

- None.

New Features and Enhancements

- The regions-of-interest feature (ROI), has been added to the following instrumentation clients:

```
api/samples/inscount_emulated.cpp
api/samples/instrace_emulated.c
api/samples/memtrace_emulated.c
api/samples/opcodes_emulated.cpp
```

Bug Fixes

- An ELF loader bug which resulted in failures when running Fortran binaries has been fixed.

Other Changes

- Documentation has been updated to include more information about analysing specific aspects of runtime performance using existing instrumentation clients, or developing your own. See:
  - https://developer.arm.com/tools-and-software/server-and-hpc/arm-architecture-tools/arm-instruction-emulator
  - https://developer.arm.com/tools-and-software/server-and-hpc/arm-architecture-tools/arm-instruction-emulator/tutorials

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- https://developer.arm.com/tools-and-software/server-and-hpc/arm-architecture-tools/arm-instruction-emulator/structure-of-an-instrumentation-client
- https://developer.arm.com/tools-and-software/server-and-hpc/arm-architecture-tools/arm-instruction-emulator/building-custom-analysis-instrumentation
- https://developer.arm.com/tools-and-software/server-and-hpc/arm-architecture-tools/arm-instruction-emulator/building-an-emulation-aware-instrumentation-client

Change in Release 18.4

Removed Features

- None.

New Features and Enhancements

- None.

Bug Fixes

- This version can successfully run multi-threaded subject binaries, including those linked with OpenMP libraries.

Other Changes

- None.

Changes in Release 18.3

Removed Features

- None.

New Features and Enhancements

- Emulation has been separated from instrumentation based on the addition of an emulation interface to the DynamoRIO API allowing users to develop their own instrumentation clients:

```
drmgr_is_emulation_start()
drmgr_is_emulation_end()
drmgr_get_emulation_instr_data()
drmgr_create_emulation_start()
drmgr_create_emulation_end()
emulated_instr_t
```

  Two instruction count clients, an opcodes client and a memory trace client have been provided as examples. Another emulation feature to simplify iteration over blocks with emulated instructions is planned for a future release. If accepted upstream, this emulation-aware iterator will simplify instrumentation when running with emulation clients.

Bug Fixes

- None

Other Changes

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- A script, `enc2instr.py`, which can be used to disassemble instruction encodings to mnemonics. Useful for disassembling the output from `drmgr_get_emulation_instr_data()`. The script is based on llvm-mc and defaults to disassembling SVE, but can be any legal `-mattr` value supported by llvm-mc.
- All license files are now in the `license_terms` directory.

Changes in Release 18.2

Removed Features

- None.

New Features and Enhancements

- This release begins the process of separating emulation clients from instrumentation clients. The implementation of an instruction count client and memory tracing clients are the first examples of such a separation.

Bug Fixes

- A bug in counting non-SVE instructions has been fixed.

Other Changes

- A helper option to output the full `drrun` command used by `armie`: `-s, --show-drrun-cmd`.

Changes in Release 18.1

Removed Features

- None.

New Features and Enhancements

- There are significant improvements in runtime performance principally due to optimisations in SVE emulation functions (mostly floating-point emulation including faster FCMLA) and memory copying.

Bug Fixes

- Floating point corrections including:
  - Handling of inactive vector elements.
  - Floating point <-> integer conversions.
  - FPSR updates by and for modifying instructions.
  - Operand ordering for commutative operations.
  - Handling of NaNs.

Other Changes

- None.

Changes in Release 18.0

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This is the first release which integrates ArmIE with the Open Source DynamoRIO dynamic binary instrumentation platform (http://www.dynamorio.org/home.html). The previous release of Arm Instruction Emulator was 1.2.1. The version numbering scheme has changed with this release in order to remain consistent with other Arm AArch64 HPC software tools.

Removed Features

The functionality enabled by the following command line options is not available in this release. They may be added in future releases.

- `-d, --debug`

  Enabled assertion checks in the emulator.

- `-o, --output`

  Redirected all messages generated by armie to a file.

- `-p, --profile-period`

  Enabled the performance profiler.

- `-msve-memtrace`

  Enabled memory tracing.

New Features

- Arm Instruction Emulator 18.0 runs using DynamoRIO clients to provide SVE emulation and limited instrumentation for both emulated SVE instructions and native AArch64 instructions. Previous releases emulated SVE instructions with no coverage of native AArch64 instructions.

Bug Fixes

- None. This is the first release based on DynamoRIO.

Other Changes

- None.

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