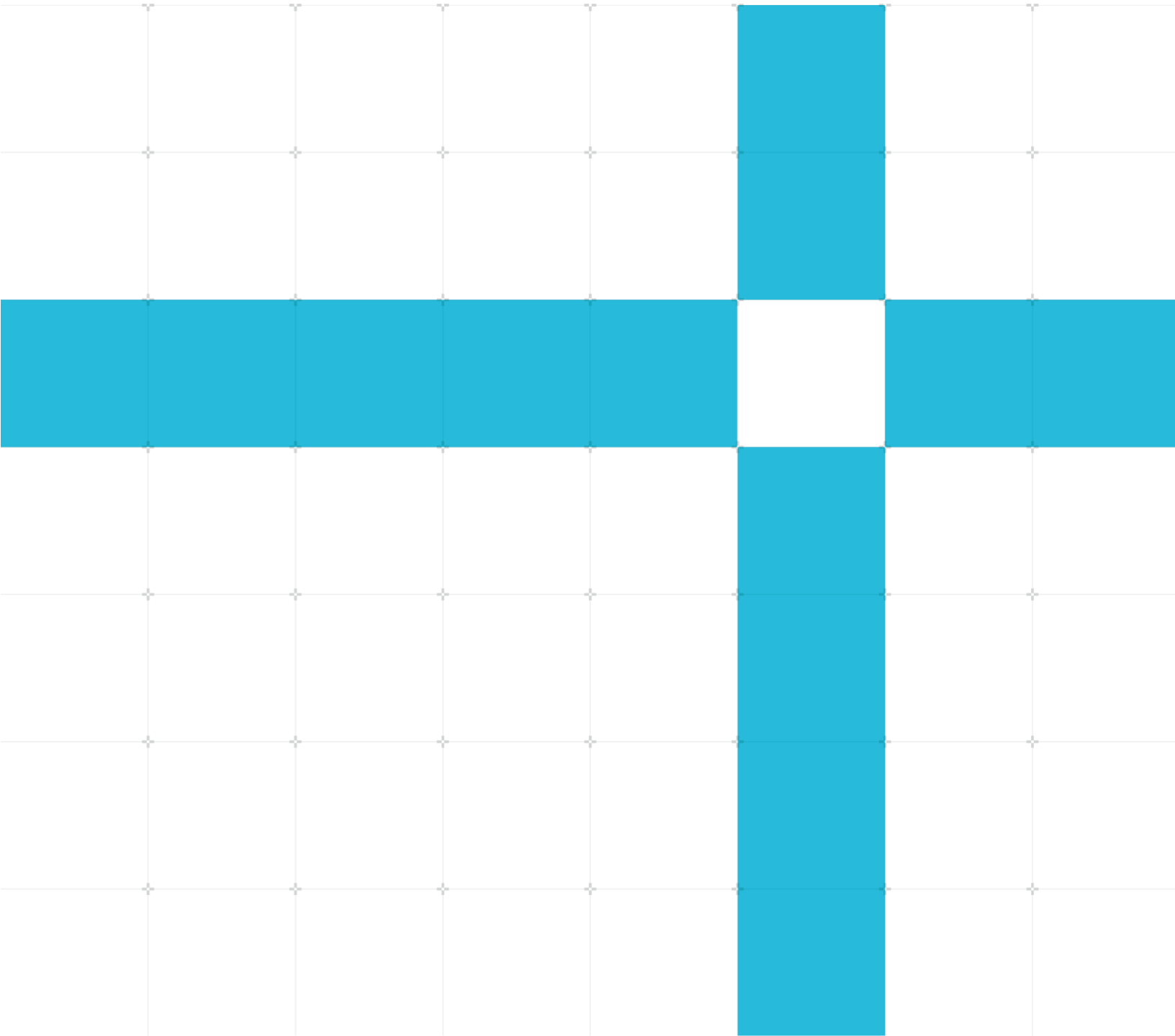
Arm® Mobile Studio 2023.5

Product revision: r23p5-00rel0

Release Note

Non-Confidential

Issue 00
DSHVE-DC-06003



Arm Mobile Studio 2023.5

Release Note

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(LES-PRE-20349)

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Contents

1 Release overview

The following sections describe the product and its quality status at time of release.

1.1 Product description

Arm® Mobile Studio is a tool suite enabling Android application developers to detect performance bottlenecks in their Arm CPU software and Arm Immortalis™ and Arm Mali™ GPU rendering. Profiling is provided through analysis of performance counters from the hardware, and the target application's graphics API usage.

This release of Arm Mobile Studio includes:

- Streamline, for profiling application software and system rendering performance. Streamline integrates Performance Advisor, a reporting tool used for automating rendering performance analysis and reporting in continuous integration deployments.
- NEW! Frame Advisor, for profiling rendering efficiency and usage of graphics APIs.
- Mali Offline Compiler, for static analysis of shader programs and compute kernels.
- Graphics Analyzer, for debugging and inspecting usage of graphics APIs.

1.1.1 Component versions

This release of Arm Mobile Studio includes the following tool versions:

- Streamline 8.9
- Frame Advisor 1.0
- Mali Offline Compiler 8.2
- Graphics Analyzer 5.12.2

1.2 Release status

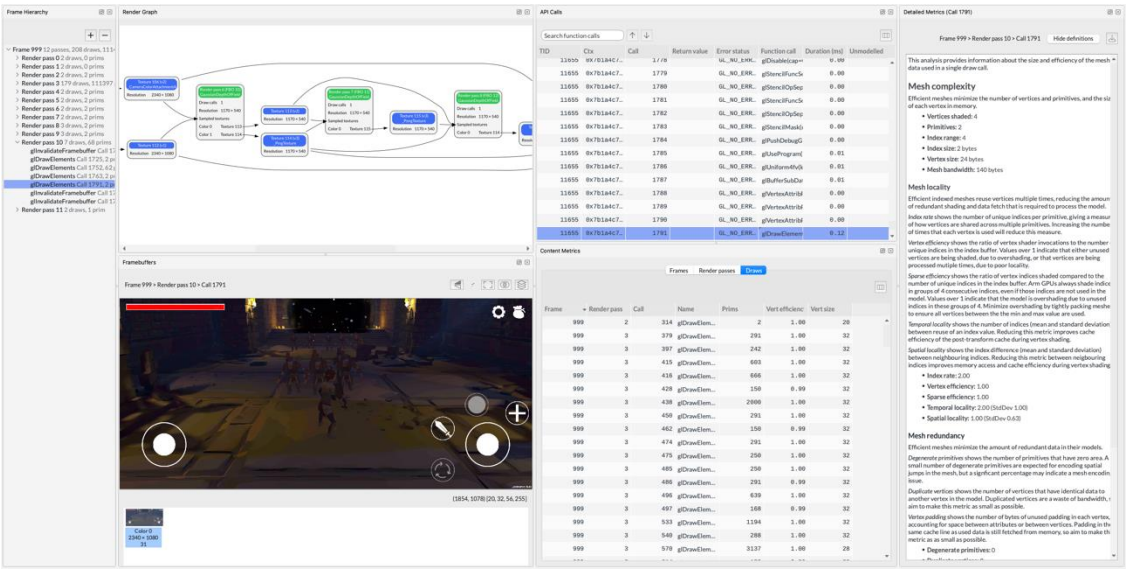
This is the REL quality release of the Arm Mobile Studio 2023.5 (r23p5-00rel0) software.

1.3 Introducing Frame Advisor

This release introduces a new tool into the studio, an early access release of Frame Advisor, the next generation of our API-aware performance tooling. This tool is a graphics profiler, which captures the API calls and GPU output for selected application frames.

This tool is designed to focus on performance analysis and linting for Arm® GPU best practice recommendations, enabling you to see how your application is performing on Arm GPUs and uncover performance issues. You can use the analysis that Frame Advisor provides to

understand how your frame is built up using GPU workloads, the data flow between these GPU workloads, and the efficiency of the rendering commands within each render pass workload.



Using Frame Advisor, you can:

- See the structure of your frame in the Render Graph view, which shows how the GPU processes your render passes and how data flows between them.
- Inspect how your application constructs each render pass by stepping through draw calls in the Framebuffer view, including support for the popular overdraw visualization from Graphics Analyzer.
- Find expensive or inefficient draw calls in the tabular Metrics view, and then analyze problem cases in the Detailed Metrics view, which presents a comprehensive analysis of a single draw call.

> Frame Advisor will focus on profiling use cases and performance analysis. For functional debugging we recommend using the open-source RenderDoc tool.

1.3.1 Feedback

Frame Advisor is a new tool, and this first early access release focuses on providing a small number of analysis features that we believe are most useful for mobile application developers.

This first release has several known issues, and we have a long roadmap of features and optimizations to implement, so this tool will continue to improve and evolve over the next few years. This version has been primarily developed on Windows and macOS, and we would highlight that there are some dependency issues on Ubuntu Linux that require users to manually install some of the missing libraries. This will be fixed in the next release. Please refer to the Known Issues in section 1.5.2 of this document for information about missing functionality and performance problems in this release.

We love to hear developer feedback, and prioritize things that developers ask for, so please let us know about any bugs you encounter, or feature requests for a future release.

You can send feedback **using this form**, or you can email us at mobilestudio@arm.com.

1.3.2 The near-term roadmap

As a new tool, we would like to let you know where we are headed over the next few releases. Here is a look at what we are planning.

> **Important!** This roadmap is subject to change as we get feedback from developers.

- Host support:
  - Improved support for Linux host machines.
- Optimizations:
  - Improve capture performance.
  - Reduce host tool memory footprint.
  - Reduce saved capture file size.
- API coverage
  - Add support for missing draw types.
  - Add support for transfer workloads.
  - Add support for compute workloads.
  - Add support for Vulkan 1.3 and dynamic rendering.
- Data visualizations
  - Add support for an interactive 3D mesh visualization.
  - Add support for a tabular program/pipeline shader metrics visualization.

1.3.3 Get started with Frame Advisor

Here's how to get up and running with Frame Advisor.

Before you begin

- Ensure you have Android Debug Bridge (ADB) installed.
- Connect your device to your computer via USB.
- Your device needs to be in developer mode, with USB debugging enabled.
- The build of your Android application must be debuggable.

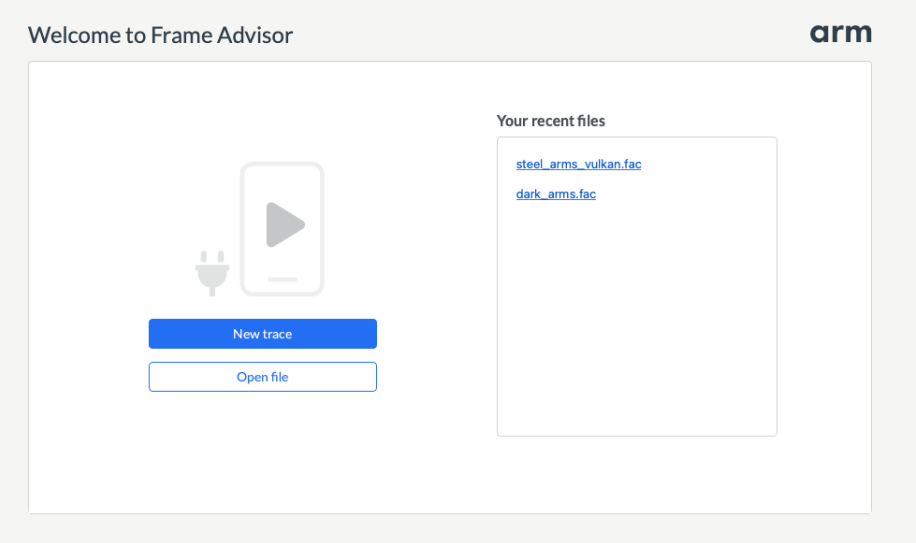
Procedure

1. Open Frame Advisor:
   - On Windows, from the **Start** menu, navigate to **Arm MS <version>** and select **Arm MS Frame Advisor <version>**.
   - On macOS, navigate to the *<install_directory>/frame_advisor* folder, and double-click the **Frame_Advisor.app** file.

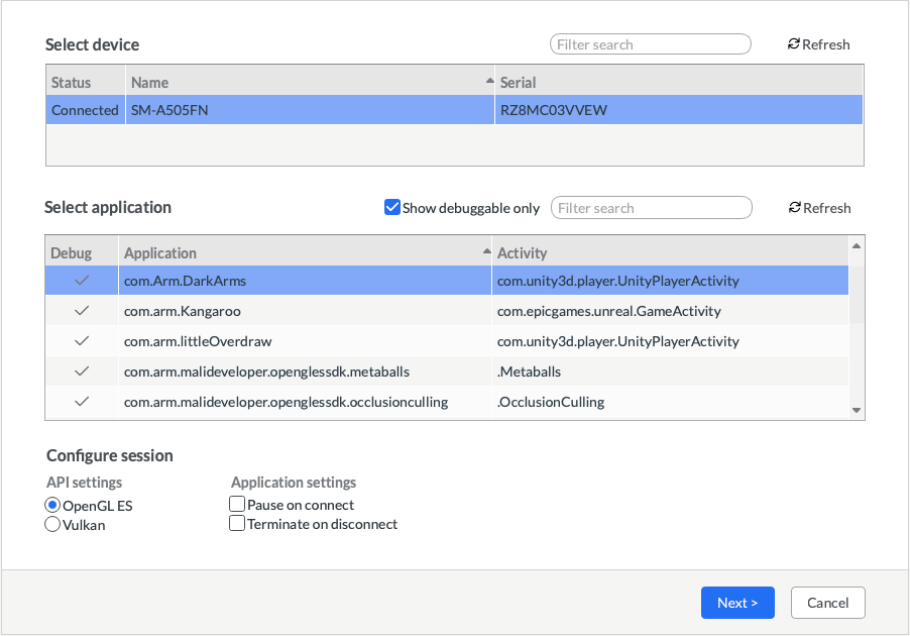
- On Linux, navigate to the *<install_directory>/frame_advisor* directory in a terminal, and run the **frame_advisor** file:

```
cd <install_directory>/frame_advisor
./frame_advisor
```

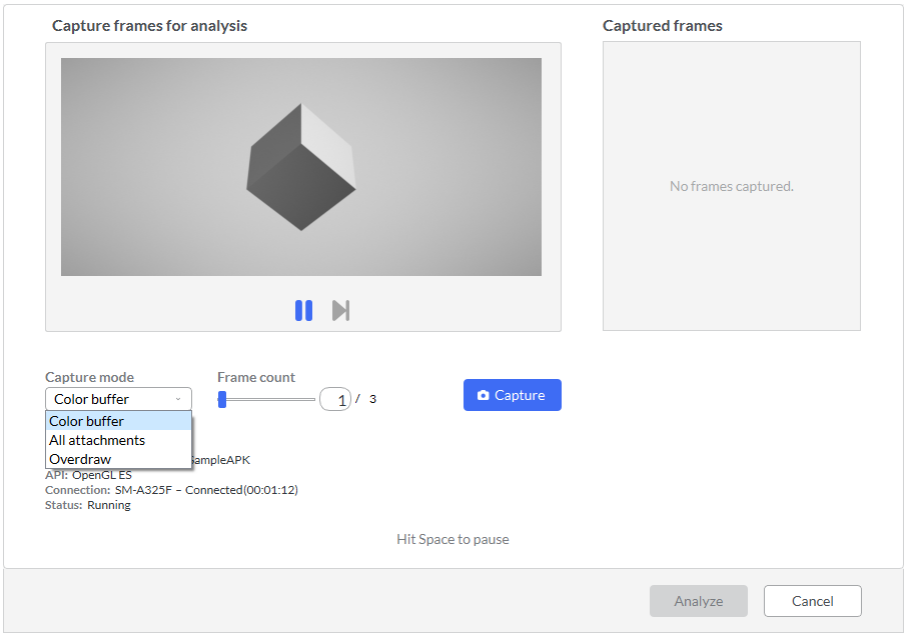
2. When Frame Advisor launches, select **New trace**.



3. Select your device and the application you want to analyze.



4. If your application is using Vulkan change the **API settings** to **Vulkan**.
5. Click **Next >** . The application starts on the device and Frame Advisor shows the **Capture** screen.



6. On the **Capture** screen, you can optionally:
    a. Increase the number of frames to capture (max 3).
    b. Change the capture mode to capture all attachments, or overdraw only.
7. Click **Pause** just before you get to the problem scene in your application. Use the step button to focus in on the right place.
8. Click **Capture** to start capturing the frame(s).
9. When the capture completes, click **Analyze** to view the results. Frame Advisor processes the data and presents it in the Analysis screen. Now you can explore your frames to evaluate how efficiently they were rendered to the device.

See the ***Frame Advisor user guide*** for further details about how to analyze the data.

1.4 Changes in this release

This release of Arm Mobile Studio contains the following changes.

1.4.1 Mobile Studio

Mobile Studio has the following changes:

- Frame Advisor is now included in the release bundle.

1.4.2 Streamline

Streamline has the following changes:

- Android device connection now supports passing command line options.
- Android device connection now supports passing a non-launchable activity.

- Performance Advisor report generation is now much faster.
- Fix: Counter capture now works around a driver erratum that users have encountered on recent Immortalis-G715 and Mali-G715 series devices.
- Deprecation notice: Energy profiling using Arm Energy Probe, or an NI DAQ probe, is a deprecated feature. It will be removed in a future release.

1.4.3 Frame Advisor

Frame Advisor has the following changes:

- This is the first release of Frame Advisor.

1.4.4 Mali Offline Compiler

Mali Offline Compiler has the following changes:

- Compiler libraries updated to r45p0 DDK for Bifrost architecture, or newer.
- Variable shading rate static analysis added to vertex shader reports if emitting a per-primitive shading rate.

1.4.5 Graphics Analyzer

Graphics Analyzer has the following changes:

- No changes in this release.
- Deprecation notice: Graphics Analyzer is now deprecated. It will be removed in a future release, but only after we decide Frame Advisor is providing enough to be considered a viable replacement.

Graphics Analyzer has the following known issues:

- SDDAP-12605: Tool loading splash-screen renders upside down on macOS 14 (Sonoma).

1.5 Known issues in this release

This release of Arm Mobile Studio contains the following known issues.

1.5.1 Streamline

Streamline has the following known issues:

- SDDAP-12605: Application loading splash-screen renders upside down on macOS 14 (Sonoma).
- SDDAP-12653: Application can crash when toggling between OS light and dark themes on macOS 14 (Sonoma).
- SDDAP-12290: The Mali DDK can fail to emit the Perfetto data required for the scheduling timeline visualization. This can result in entries with unidentified processes and queues. It

can also result in time ranges which show as idle in the scheduler timeline when the GPU is clearly active in the counter data.

- SDDAP-11426: High DPI display scaling has been disabled by default on Linux hosts, due to persistent reliability issues across multiple distributions and graphics drivers. If desired, display scaling support can be re-enabled by setting the environment variable `STREAMLINE_ENABLE_HIDPI` to 1 and restarting the tool.

1.5.2 Frame Advisor

Frame Advisor has the following known issues:

- FRADV-5238: On Ubuntu 20.04, the host tool is missing a sufficiently new GLIBC library dependency. Users can manually install the missing dependency using:
```
sudo add-apt-repository -y ppa:ubuntu-toolchain-r/test
sudo apt update && apt upgrade -y
sudo apt install -y gcc-11 g++-11
```
- FRADV-5236: On Ubuntu 22.04 or newer, the host tool is missing libicui18n.so.66 library dependency. Users can manually install the missing dependency using:
```
wget http://security.ubuntu.com/ubuntu/pool/main/i/icu/libicu66_66.1-2ubuntu2_amd64.deb
sudo apt update && sudo dpkg -i libicu66_66.1-2ubuntu2_amd64.deb
```
- FRADV-4806: Host tool does not display properly on macOS when using the dark mode system theme.
- FRADV-4931: Host tool needs further memory optimization during capture and post-analysis. It is recommended to use this version on a host machine with at least 16GB of memory. If memory allocation problems are encountered, try capturing fewer frames to reduce memory requirements.
- FRADV-4842: FAC files need further size optimization. If file storage capacity problems are encountered, try capturing fewer frames to reduce storage requirements.
- FRADV-865: Frame capture can take a long time and needs further performance optimization.
- FRADV-4841: API modelling is not yet handling indirect draws.
- FRADV-4841: API modelling is not yet handling base-vertex draws.
- FRADV-4978: API modelling is not yet fully handling multi-context OpenGL ES applications, although it should mostly work.
- FRADV-4979: API modelling is not yet handling resources that are uploaded and unmapped before the start of the captured frame burst.
- FRADV-4972: API modelling is not yet handling OpenGL ES vertex array objects.
- FRADV-4966: API modeling is not yet handling Vulkan descriptor set updates that use `vkUpdateDescriptorSetsWithTemplate()`. This can cause draw calls to be missing geometry statistics and links to be missing in the Render Graph view. This is known to cause missing geometry metrics in applications using the Unity game engine.

- FRADV-3557: API modelling is not yet handling Vulkan 1.3 or the dynamic rendering extensions.
- FRADV-4980: API modelling is not handling command buffers that are created before the captured frame burst. Note, currently we have no plan to support this functionality, as doing so would be very invasive to application performance.
- FRADV-3898: Actual and Ideal mesh memory bandwidth is not yet factoring in the position/non-position attribute use in the vertex shader; the only factor considered is the presence of padding bytes in the buffer memory layout.
- FRADV-3546: Transfer commands are not yet treated as workloads for the purposes of navigation or the Render Graph view.
- FRADV-4639: Compute dispatches are not yet treated as workloads for the purposes of navigation or the Render Graph view.
- FRADV-3558: Float image formats are not yet supported in the Framebuffer view.
- FRADV-4950: Render Graph view doesn't currently reflect the effect of Vulkan read-only attachments or optimized `storeOp` behaviors.
- FRADV-4951: Render Graph view doesn't currently reflect the effect of Vulkan resolve attachments.

2 Support

To help you get started we provide a number of quick start guides available online:

- Get started with Streamline
- Get started with Frame Advisor
- Get started with Performance Advisor
- Get started with Graphics Analyzer
- Get started with Mali Offline Compiler

Technical support for Arm Mobile Studio is provided via our developer forums:

- Developer forums on community.arm.com

2.1 How-to videos

Refer to the following videos to learn how to use Arm Mobile Studio tools.

- Streamline
- Performance Advisor
- Graphics Analyzer
- Mali Offline Compiler

To learn more about Mali GPUs and how to develop optimized graphics content for mobile devices, refer to the **Mali GPU Training Series**.

2.2 Host OS support

This release has been developed for the following host operating systems:

Table 2-1: Host operating system used in developing this release

Operating system	Version
Windows	10 or newer
macOS	10.15 (Catalina) or newer
Ubuntu Linux	20.04 (Focal Fossa) or newer

2.3 Target OS support

This release has been developed for the following target operating systems:

Table 2-2: Target operating system used in developing this release

Feature	Version
Streamline	Android 8 or newer
Streamline Performance Advisor for OpenGL ES applications	Android 8 or newer with manual annotation Android 10 or newer with the Light-weight Interceptor
Streamline Performance Advisor for Vulkan applications	Android 9 or newer
Frame Advisor for OpenGL ES applications	Android 10 or newer
Frame Advisor for Vulkan applications	Android 9 or newer
Graphics Analyzer OpenGL ES	Android 8 or newer
Graphics Analyzer Vulkan	Android 9 or newer

2.4 Related projects

Arm provides several open-source projects that can be used by application developers as part of their application development.

2.4.1 Mobile Studio for Unity package

Current version: 1.5.0 (September 2022)

The Mobile Studio for Unity package provides an open-source Unity game engine integration for Streamline and Performance Advisor. The package provides:

- C# bindings for Streamline's annotation API, allowing users to export custom software counters, and event annotations.
- Integration with the Unity profiler data source, exporting Unity object counts and memory allocations as custom software counters.

The annotation API provides a generic means to markup a Streamline capture. It can be used to emit the semantic tags that Performance Advisor reports use to denote interesting gameplay regions.

Recent changes:

- None.

The package is available on GitHub and can be imported directly into your Unity project using the Unity package manager. See the GitHub project documentation for more details.

- https://github.com/ARM-software/mobile-studio-integration-for-unity/

2.4.2 ASTC Encoder texture compressor

Current version: 4.6.1 (November 2023)

The Arm ASTC Encoder (astcenc) is an open-source texture compressor for the Adaptive Scalable Texture Compression (ASTC) texture format. It supports all block sizes, all color profiles, as well as both 2D and volumetric 3D textures. The astcenc compressor can be built as

either a standalone command line application or a library that can be integrated into an existing asset creation pipeline.

4.6.1 release changes:

- Removed core codec use of `reinterpret_cast` outside of the SIMD libraries, making the core compliant with strict-aliasing rules.
- Improved heuristic tuning and tuning limits for a small improvement to performance and small reduction in memory footprint.
- Fixed a memory leak that occurred when allocating a decompress-only context in a full compressor build.
- Improved performance on Windows systems with more than 64 cores.

The source code is available on GitHub, in addition to binary releases of the command line utility for Windows, macOS, and Linux.

- https://github.com/ARM-software/astc-encoder

2.4.3 HWCPipe library

Current version: 2.2.0 (November 2023)

The Hardware Counter Pipe (HWCPipe) library is an open-source utility that allows applications to select and sample a set of Arm GPU performance counters. This library provides access to the same counter data that can be visualized in the Streamline tool, allowing integration of Arm GPU data into custom tooling.

2.2.0 release changes:

- Arm Midgard architecture GPUs now return an execution engine count instead of zero.
- Arm Mali-G78AE now returns a warp width instead of zero.
- Arm 5th Generation architecture GPUs now have improved counter names and expressions reflecting the semantic changes introduced by deferred vertex shading.
- A workaround has been implemented for a kernel interface version vs kernel interface implementation mismatch in some shipping Immortalis-G715 devices.

The source code is available on GitHub:

- https://github.com/ARM-software/HWCPipe

2.4.4 libGPUInfo library

Current version: 1.0.0 (June 2023)

The libGPUInfo library is an open-source utility that can be integrated into an application to query the configuration of the Arm GPU present in the system, including the GPU model, shader core count, shader core performance characteristics, and cache size. This information can be used to adjust the application workload at runtime to match the capabilities of the device being used.

1.0.0 release changes:

- Added an option for emitting YAML output to the command-line support utility.
- Added dynamic IP configuration query support for the Mali-G310 and Mali-G510 GPUs, as the arithmetic and texturing performance of each shader core can be configured by the chipset manufacturer.

The source code is available on GitHub:

- https://github.com/ARM-software/libGPUInfo

3 Installation

This section describes how to install and configure Arm Mobile Studio to run on 64-bit Windows, macOS®, and Linux.

Mobile Studio requires Android Debug Bridge (ADB) and Python 3.8 (or newer), to enable connection to your device. Make sure you have these tools installed and that you have configured your environment to use them.

3.1 Install on Windows

Arm Mobile Studio is provided with an installer executable. Double-click the **.exe** file and follow the instructions in the setup wizard.

- To open Streamline, open the Windows Start menu, navigate to the Arm Mobile Studio folder, and select the "Arm MS Streamline 2023.5" shortcut,
- Performance Advisor is a command-line tool that is part of the Streamline application. To use it to generate a performance report, you must first run the provided Python script to enable Streamline to collect frame data from the device. This process is described in detail in the Get started with Performance Advisor tutorial.

  Once you have captured a profile with Streamline, run the `Streamline-cli -pa` command on the Streamline capture file. This command is added to your PATH environment variable during installation, so it can be used from anywhere.

  ```
  Streamline-cli.exe -pa <options> my_capture.apc
  ```
- To open Graphics Analyzer, open the Windows Start menu, navigate to the Arm Mobile Studio folder, and select the "Arm MS Graphics Analyzer 2023.5" shortcut.
- To run Mali Offline Compiler, open a command terminal, navigate to your work directory, and run the `malioc` command on a shader program. The `malioc` command is added to your PATH environment variable during installation, so can be used from anywhere.

  ```
  malioc.exe <options> my_shader.frag
  ```
- To open Frame Advisor, from the **Start** menu, navigate to **Arm MS <version>** and select **Arm MS Frame Advisor <version>**.

3.2 Install on macOS

Arm Mobile Studio is provided as a **.dmg** package. To mount it, double-click the **.dmg** package and follow the instructions. The Mobile Studio directory tree is copied to the **Applications** directory on your local file system for easy access.

Open the tools directly from the Arm Mobile Studio directory in your Applications directory.

- To open Streamline, go to the **<installation_directory>/streamline** directory, and open the **Streamline.app** file.

- To run Performance Advisor, go to the **<installation_directory>/streamline** directory, and double-click the **Streamline-cli-launcher** file. Your computer will ask you to allow Streamline to control the Terminal application. Allow this.

  The Performance Advisor launcher opens the Terminal application and updates your PATH environment variable so you can run Performance Advisor from any directory.

  Performance Advisor is a command-line tool that is part of the Streamline application. To use it to generate a performance report, you must first run the provided Python script to enable Streamline to collect frame data from the device. This process is described in detail in the Get started with Performance Advisor tutorial.

  Once you have captured a profile with Streamline, run the **`Streamline-cli -pa`** command on the Streamline capture file to generate a performance report:

  ```
  Streamline-cli -pa <options> my_capture.apc
  ```

- To open Graphics Analyzer, go to the **<installation_directory>/graphics_analyzer/gui** directory and open the **Graphics Analyzer.app** file.
- To run Mali Offline Compiler, go to the **<installation_directory>/mali_offline_compiler** directory, and double-click the **mali_offline_compiler_launcher** file.

  The Mali Offline Compiler launcher opens the Terminal application and updates your PATH environment variable so you can run the **`malioc`** command from any directory.

  To generate a shader analysis report, run the **`malioc`** command on a shader program:

  ```
  malioc <options> my_shader.frag
  ```

  On some versions of macOS, you might see a message that Mali Offline Compiler is not recognized as an application from an identified developer. To enable Mali Offline Compiler, cancel this message, then open **System Preferences > Security and Privacy**, and select **Allow Anyway** for the **`malioc`** application.
- To open Frame Advisor, navigate to the *<install_directory>/frame_advisor* folder, and double-click the **Frame_Advisor.app** file.

3.3 Install on Linux

Arm Mobile Studio is provided as a gzipped tar archive. Extract this tar archive to your preferred location, using a recent version (1.13 or later) of GNU tar:

```
tar xvzf Arm_Mobile_Studio_2023.5_linux.tgz
```

Open the tools directly from the location where you extracted the package.

- To open Streamline, go to the **<installation_directory>/streamline** directory and run the **`Streamline`** file.

  ```
  cd <installation_directory>/streamline
  ./Streamline
  ```

- Performance Advisor is a command-line tool that is part of the Streamline application. To use it to generate a performance report, you must first run the provided Python script to

enable Streamline to collect frame data from the device. This process is described in detail in the Get started with Performance Advisor tutorial.

Once you have captured a profile with Streamline, go to the <installation_directory>/streamline directory and run the `Streamline-cli -pa` command on the Streamline capture file to generate a performance report:

```
cd <installation_directory>/performance_advisor
./Streamline-cli -pa <options> my_capture.apc
```

- To open Graphics Analyzer, go to the <installation_directory>/graphics_analyzer/gui directory and run the **aga** file.

  ```
  cd <installation_directory>/graphics_analyzer/gui
  ./aga
  ```

- To run Mali Offline Compiler, go to the <installation_directory>/mali_offline_compiler directory and run the `malioc` command on a shader program.

  ```
  cd <installation_directory>/mali_offline_compiler
  ./malioc <options> my_shader.frag
  ```

- To open Frame Advisor, navigate to the *<install_directory>/frame_advisor* directory in a terminal, and run the **`frame_advisor`** file:

  ```
  cd <install_directory>/frame_advisor
  ./frame_advisor
  ```

You might find it useful to edit your PATH environment variable to add the paths to the **`Streamline-cli`** and **`malioc`** executables so that you can run them from any directory. Add the following commands to the **.bashrc** file in your home directory, so that they are set whenever you initialize a shell session:

```
PATH=$PATH:/<installation_directory>/streamline
PATH=$PATH:/<installation_directory>/mali_offline_compiler
```