Arm® Performance Studio 2024.0

Product revision: r24p0-00rel0

Release Note

Non-Confidential

Issue 00
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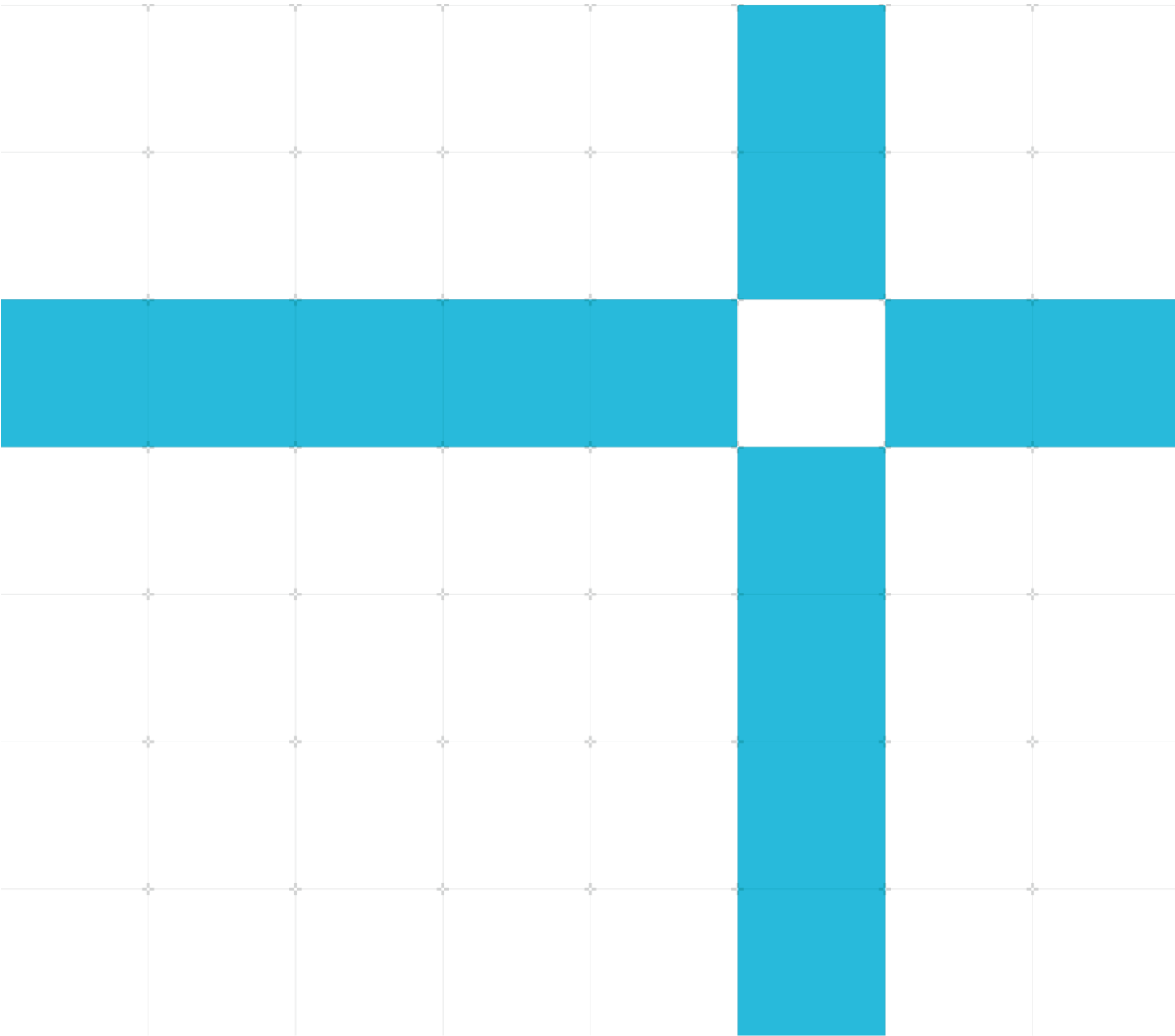

Arm Performance Studio 2024.0

Release Note

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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® Performance Studio is a tool suite enabling 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 Performance 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.
- Frame Advisor, for profiling rendering efficiency and usage of graphics APIs.
- Mali Offline Compiler, for static analysis of shader programs and compute kernels.
- RenderDoc for Arm GPUs, for debugging and inspecting usage of graphics APIs.
- Graphics Analyzer, for debugging and inspecting usage of graphics APIs (deprecated).

1.1.1 Component versions

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

- Streamline 9.0
- Frame Advisor 1.1
- Mali Offline Compiler 8.3
- RenderDoc for Arm GPUs 2024.0
- Graphics Analyzer 5.13

1.1.2 About RenderDoc for Arm GPUs

RenderDoc for Arm GPUs is an Arm fork of RenderDoc, an open-source graphics API debugger. The Arm release includes support for API features and extensions that are available on the latest Arm GPUs, but not yet supported in upstream RenderDoc.

Arm intends to contribute changes to the upstream project, if they are willing to accept, but inevitably some Arm-specific features will only be available on the Arm fork.

1.2 Release status

This is the REL quality release of the Arm Performance Studio 2024.0 (r24p0-00rel0) software.

1.3 Feedback

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 performancestudio@arm.com.

1.4 Changes in this release

This release of Arm Performance Studio contains the following changes.

1.4.1 Performance Studio

Performance Studio has the following changes:

- Arm Mobile Studio has been renamed to Arm Performance Studio.
- Support for Arm Linux targets has been added to Streamline and Graphics Analyzer.
- Support for bare metal targets has been added to Streamline.
- RenderDoc for Arm GPUs has been added to the bundle.

1.4.2 Streamline

Streamline has the following changes:

- Support for Arm Linux targets has been added.
- Support for Arm bare-metal targets has been added.
- Support for automatic multiplexing of CPU metric counter groups has been added.
- Support for a Summary analysis level has been added, allowing for a lower resolution but faster data analysis. This is suitable for analyzing long-running captures on Arm Neoverse systems with many CPU cores.
- Support for prototype command line CPU analysis tools implementing function-attributed metrics. These are intended for use on systems running on Linux on a Neoverse CPUs.
- Improved support for Arm 5th Generation GPUs in Performance Advisor reports.
- Added support for advanced Vulkan draw type counters to the Performance Advisor light-weight interceptor.
- 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:

- Reduced analysis time and file load time.
- Reduced tool memory footprint and file size. Note that this changes the FAC file encoding, so captures made with v1.0 are not compatible with the host tool in this release.
- Improved Render Graph view compactness and readability.
- Support new Vertex Memory Efficiency and Vertex Shader Efficiency aggregated metrics for the Content metrics view, reducing the number of columns needed to give a complete at-a-glance summary of model encoding efficiency.
- Fix: Correctly handle more render pass clear/invalidate and loadOp/storeOp states in the Render Graph view.
- Fix: Improved compatibility with more Linux host OS versions.
- Fix: Improve compatibility with macOS devices using the OS dark theme.

1.4.4 Mali Offline Compiler

Mali Offline Compiler has the following changes:

- Fix: Uniform register utilization percentage now reported correctly for Arm Bifrost and newer architectures.

1.4.5 RenderDoc for Arm GPUs

RenderDoc for Arm GPUs is based on upstream RenderDoc 1.31, and has the following changes:

- Capturing applications using `VK_KHR_ray_query`.
- Capturing applications using `VK_KHR_acceleration_structure` for device-side acceleration structure builds.
- Capturing on Android with other Vulkan layers installed in addition to the RenderDoc layer.
- Automatically enabling storage permissions for debugged Android applications.

1.4.6 Graphics Analyzer

Graphics Analyzer has the following changes:

- Linux target support has been added.
- 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.

1.5 Known issues in this release

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

1.5.1 Streamline

Streamline has the following known issues:

- 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. This is fixed in the Mali DDK r47p0 release.
- 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-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-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()` inside a frame burst. This can cause draw calls to be missing geometry statistics and links to be missing in the Render Graph view.
- 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, 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-4951: Render Graph view doesn't currently reflect the effect of Vulkan resolve attachments.
- Modelling is not handling stencil-only surface attachments for OpenGL ES or Vulkan. Packed depth-stencil surfaces are supported.

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 Performance 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 Performance Studio tools.

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

To learn more about Arm Immortalis and 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 version support

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

Table 2-2: Host operating system feature availability

Operating system	Version
Windows	Mali Offline Compiler does not support OpenCL kernels.
macOS	RenderDoc for Arm GPUs is not supported.

2.3 Target OS support

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

Table 2-3: Target operating system version support

Feature	Version
Streamline	Android 9 or newer
Streamline Performance Advisor for OpenGL ES applications	Android 9 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	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 Performance Studio for Unity package

Current version: 1.5.0 (September 2022)

The Performance 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 Performance Studio to run on 64-bit Windows, macOS®, and Linux.

Arm Performance 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 Performance 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 Performance Studio folder, and select the "Arm PS Streamline 2024.0" 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 Performance Studio folder, and select the "Arm PS Graphics Analyzer 2024.0" 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, open the Windows Start menu, navigate to the Arm Performance Studio folder, and select the "Arm PS Frame Advisor 2024.0" shortcut.

3.2 Install on macOS

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

Open the tools directly from the Arm Performance 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 **<installation_directory>/frame_advisor** directory, and double-click the **FrameAdvisor-gui.app** file.

3.3 Install on Linux

Arm Performance 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_Performance_Studio_2024.0_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 **<installation_directory>/frame_advisor** directory in a terminal, and run the **`frame_advisor`** file:

  ```
  cd <installation_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
```