

Performance Advisor

Version 1.1

User Guide



Performance Advisor

User Guide

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Release Information

Document History

Issue	Date	Confidentiality	Change
0100-00	28 February 2020	Non-Confidential	New document for v1.0
0101-00	29 May 2020	Non-Confidential	New document for v1.1

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(LES-PRE-20349)

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Product Status

The information in this document is Final, that is for a developed product.

Web Address

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Contents

Performance Advisor User Guide

Preface

About this book	7
-----------------------	---

Chapter 1

Introduction to Performance Advisor

1.1 Overview of Performance Advisor	1-10
1.2 Performance report example	1-12
1.3 Performance Advisor workflows	1-14

Chapter 2

Before you begin

2.1 Set up your host machine	2-17
2.2 Set up your device	2-18
2.3 Integrate Performance Advisor with your application	2-19

Chapter 3

Quick start guide

3.1 Connect Streamline to your device	3-25
3.2 Choose a counter template	3-27
3.3 Capture a Streamline profile	3-28
3.4 Generate a performance report	3-29

Chapter 4

Running Performance Advisor in continuous integration workflows

4.1 Generate a headless capture	4-32
4.2 Export performance data as a JSON file	4-33
4.3 Generate multiple report types	4-36

Chapter 5	Capturing a slow frame	
5.1	Capturing slow frame rate images	5-38
5.2	Tagging slow frames	5-40
Chapter 6	Adding semantic input to the reports	
6.1	Manually create annotations from your application	6-42
6.2	Specify a CSV file containing the regions	6-44
6.3	Clip unwanted data from the capture	6-45
Appendix A	Analytics	
A.1	Analytics	Appx-A-47
Appendix B	Command-line options	
B.1	The pa command	Appx-B-49
B.2	The lwi_me.py script options	Appx-B-51

Preface

This preface introduces the *Performance Advisor User Guide*.

It contains the following:

- [About this book on page 7.](#)

About this book

This book describes how to install and use Arm® Performance Advisor to generate reports from your Arm Streamline capture data.

Using this book

This book is organized into the following chapters:

Chapter 1 Introduction to Performance Advisor

This section introduces the Performance Advisor tool and the workflows that it is designed to handle.

Chapter 2 Before you begin

Set up Arm Mobile Studio and integrate Performance Advisor with your application by following the steps in this section.

Chapter 3 Quick start guide

Performance Advisor runs on a capture file generated from Streamline. Follow the steps in this section when you are ready to perform an interactive capture.

Chapter 4 Running Performance Advisor in continuous integration workflows

Regular performance reports enable you to get instant feedback throughout your development cycle. With an Arm Mobile Studio Professional license, you can integrate Performance Advisor into your continuous integration workflow. This workflow enables you to automatically generate daily reports that help your team monitor how changes during the development cycle impact performance. Also, you can automatically generate machine-readable JSON reports that you can import into your existing performance regression tracking systems.

Chapter 5 Capturing a slow frame

Identify slow frames by using the lightweight interceptor (LWI) in different modes. Before you can use the LWI, you must first integrate it with your application.

Chapter 6 Adding semantic input to the reports

Performance Advisor can use semantic information that the application provides as key input data when generating the analysis reports.

Appendix A Analytics

Appendix B Command-line options

Glossary

The Arm® Glossary is a list of terms used in Arm documentation, together with definitions for those terms. The Arm Glossary does not contain terms that are industry standard unless the Arm meaning differs from the generally accepted meaning.

See the [Arm® Glossary](#) for more information.

Typographic conventions

italic

Introduces special terminology, denotes cross-references, and citations.

bold

Highlights interface elements, such as menu names. Denotes signal names. Also used for terms in descriptive lists, where appropriate.

`monospace`

Denotes text that you can enter at the keyboard, such as commands, file and program names, and source code.

monospace

Denotes a permitted abbreviation for a command or option. You can enter the underlined text instead of the full command or option name.

monospace italic

Denotes arguments to monospace text where the argument is to be replaced by a specific value.

monospace bold

Denotes language keywords when used outside example code.

<and>

Encloses replaceable terms for assembler syntax where they appear in code or code fragments. For example:

```
MRC p15, 0, <Rd>, <CRn>, <CRm>, <Opcode_2>
```

SMALL CAPITALS

Used in body text for a few terms that have specific technical meanings, that are defined in the *Arm® Glossary*. For example, IMPLEMENTATION DEFINED, IMPLEMENTATION SPECIFIC, UNKNOWN, and UNPREDICTABLE.

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- The number 102009_0101_00_en.
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- A concise explanation of your comments.

Arm also welcomes general suggestions for additions and improvements.

———— **Note** ————

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Other information

- [Arm® Developer](#).
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Chapter 1

Introduction to Performance Advisor

This section introduces the Performance Advisor tool and the workflows that it is designed to handle.

It contains the following sections:

- *1.1 Overview of Performance Advisor* on page 1-10.
- *1.2 Performance report example* on page 1-12.
- *1.3 Performance Advisor workflows* on page 1-14.

1.1 Overview of Performance Advisor

Performance Advisor analyzes performance data from your Arm Streamline capture, and generates a report that shows how your application is performing on your mobile device.

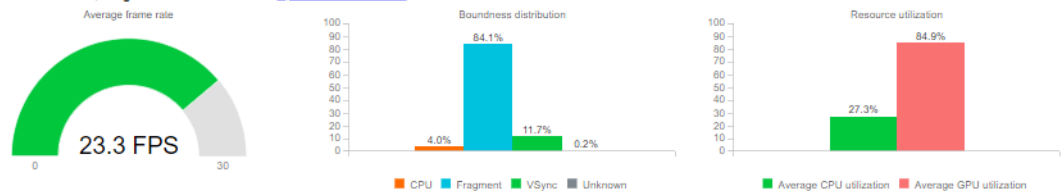
The summary at the top of the report shows whether your application is vertex or fragment bound. See how efficiently your CPU and GPU are running, your boundness split, and whether you are achieving your required frame rate.

Device information

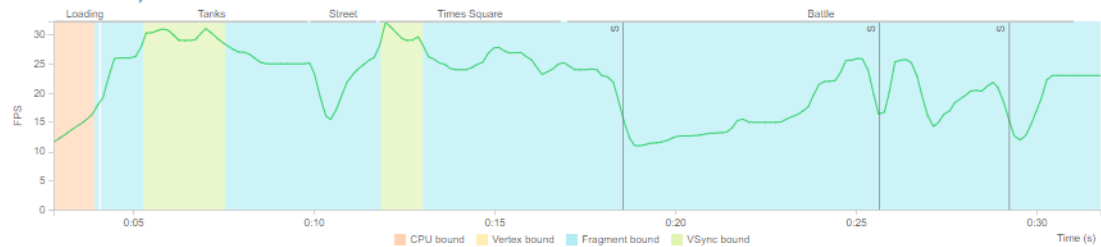
Processors: Cortex-A53 MP4, Cortex-A73 MP4, Mali-G72

Capture summary

Your application is mainly fragment bound. Read our [optimization advice](#).



Frame rate analysis



To help you further understand how your application is performing over time, you can analyze key metrics shown on a series of charts:

Overdraw per pixel

Identify problems caused by transparency or rendering order, by monitoring the number of times pixels are shaded before they are displayed.

Draw calls per frame

To identify CPU workload inefficiencies, check the absolute number of draw calls per frame.

Primitives per frame

See how many input primitives are being processed per frame, and how many of them are visible in the scene.

Pixels per frame

See the total number of pixels being rendered per frame. This metric helps you to rule out problems caused by changes in the application render pass configuration. For example, extra passes for new shadow casters or post-processing effects.

Shader cycles per frame

The total number of shader cycles per frame, broken down by pipeline, so that you can see which workloads are occupying the GPU.

GPU cycles per frame

See how the GPU is processing vertex and fragment workloads, and whether the shader core resources are balanced.

GPU bandwidth per frame

Monitor the distribution of GPU bandwidth, including the breakdown between reads and writes, so that you can minimize external memory accesses to save energy.

CPU cycles per frame

See the consumption of CPU cycles per rendered frame. This metric helps you to validate improvements and regressions, which might not be visible in the CPU utilization charts.

Running the Performance Advisor report regularly enables you to get performance feedback throughout the development cycle. You can also integrate Performance Advisor in your performance regression workflows, by generating machine-readable JSON reports that you can import into other tracking systems.

Performance Advisor can identify scheduling issues that prevent you from achieving your target frame rate, and provide advice on how to resolve it. See [3.4 Generate a performance report on page 3-29](#) for more information.

Related concepts

[1.2 Performance report example on page 1-12](#)

Related references

[Chapter 2 Before you begin on page 2-16](#)

[Chapter 3 Quick start guide on page 3-24](#)

1.2 Performance report example

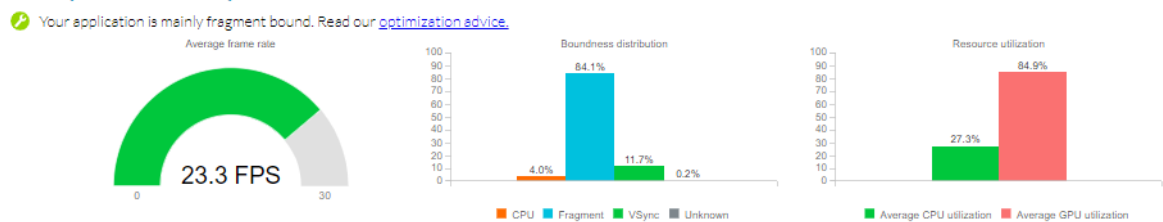
In this example, we will look at the charts in the Performance Advisor report to review the performance of your application. See how to use the report to investigate problems with any scenes in your application that are not performing well.

We have generated a Performance Advisor report from an Arm Streamline capture file, and saved it as an HTML file.

Report summary

First look at the charts at the top of the report. These three charts provide a summary of how your application is performing for the duration of your capture. To identify any changes to your application throughout your development process, we recommend that you monitor these charts regularly.

Capture summary

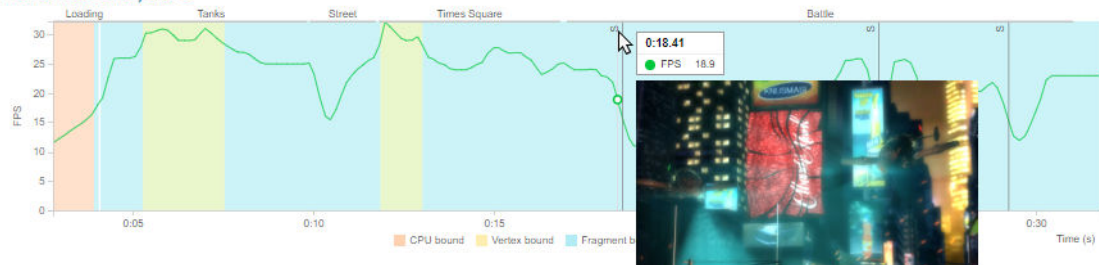


Here, we can see that the average frame rate for the capture is not achieving the target of 30fps. When we check the boundness distribution, we can see that the application is fragment bound. The utilization chart confirms that a graphical problem is causing this drop in frame rate.

Analyze frame rate

To see how the frame rate changes throughout the duration of your capture, check the **FPS analysis** chart.

Frame rate analysis



Note

In this capture, we have used the `lwi_me.py` script to take a screenshot if the frame rate goes below 20fps. We have also specified a number of frames between captures to ensure that we do not capture too many images.

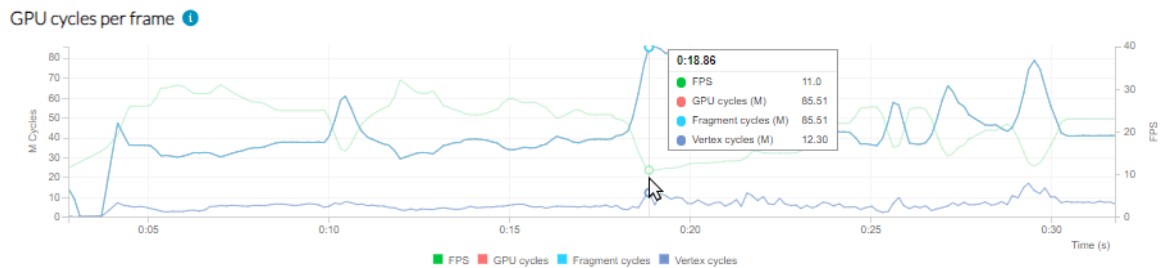
The background color of this chart is blue, indicating that the GPU in the device is struggling to process fragment workloads. We can also see that the frame rate has dropped below the target threshold of 20 in three places, so Performance Advisor has captured these frames. To see an image of the frame, hover the cursor on the screen capture icon . In the image, you might be able to see which graphical element is causing the frame rate to drop. To get a better understanding about what is happening in your application, continue your analysis by looking at the GPU behavior metrics.

Investigate GPU behavior

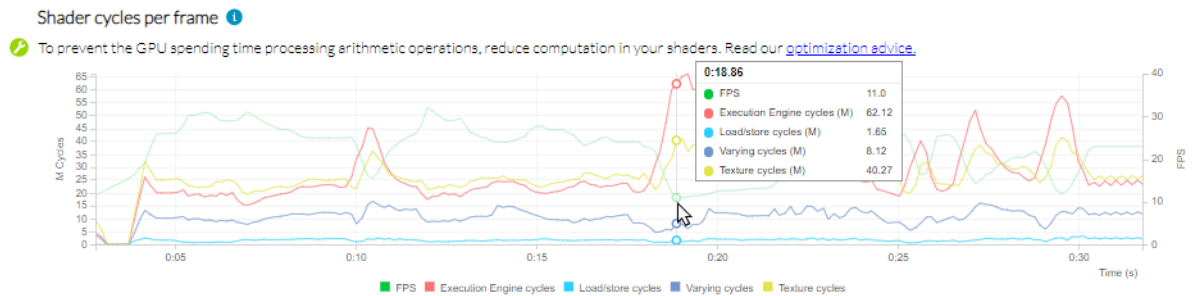
Scroll through the GPU behavior charts to find any strong correlation between the GPU metric and a drop in the frame rate. Performance Advisor provides advice above a chart where it finds a potential

problem. You can also get further advice on optimizing your code by clicking the accompanying link to our developer website.

The **GPU cycles per frame** chart shows that the frame rate drops when the number of fragment cycles increases.

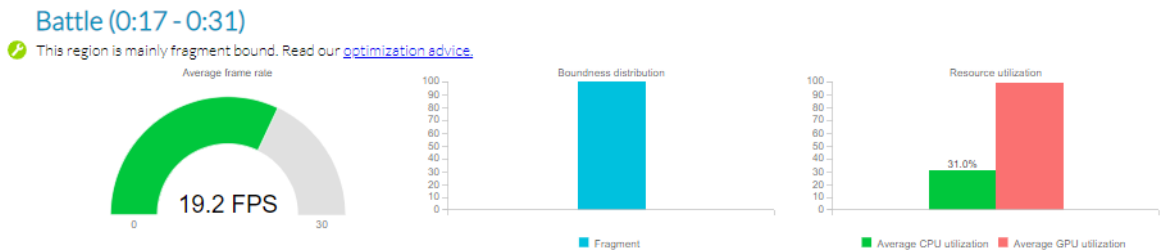


The **Shader cycles per frame** chart shows that the drop in frame rate correlates with high numbers of execution engine cycles.



This chart shows that the GPU is busy with arithmetic operations. We need to reduce the complexity of the shaders, and textures that we used. From here, we can click through to read [optimization advice](#) about how to improve shader performance.

We annotated the capture with region names to help us identify what is happening at different parts of the application. If we scroll down the report, we can analyze in more detail the specific region that we are interested in.



Next steps

When you have identified a performance problem with Performance Advisor, use the other tools in the Arm Mobile Studio suite to explore your problem in more detail.

Related information

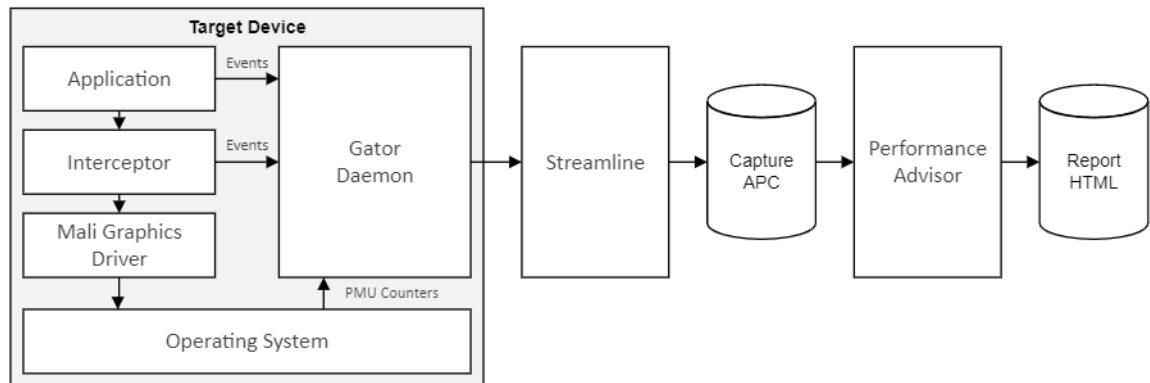
[Get started with Arm Mobile Studio](#)

1.3 Performance Advisor workflows

You can use Performance Advisor with Streamline in several different workflows, enabling you to solve multiple different types of problem.

Interactive capture with Performance Advisor report

You can use Performance Advisor to assist with a manual debug session. Manually connect to a target and capture data using Streamline. Use Performance Advisor to post-process the dataset to provide an initial quick analysis.

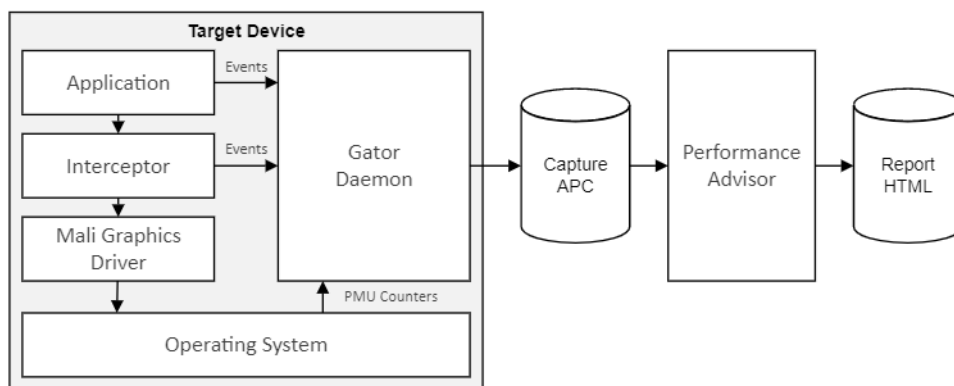


Automated capture with Performance Advisor report

Note

This feature is license managed and might not be available with some editions of Arm Mobile Studio. For more information, see [Arm® Mobile Studio Professional Edition](#).

You can use Performance Advisor as part of a continuous integration (CI) workflow. To capture data from automated game tests, without using the Streamline GUI on the host, integrate the gator daemon from Streamline into a nightly test system. Use Performance Advisor to generate a report, which can be published automatically. This workflow enables a QA team to review the status each morning.



Automated capture with Performance Advisor data export

Note

This feature is license managed and might not be available with some editions of Arm Mobile Studio. For more information, see [Arm® Mobile Studio Professional Edition](#).

You can use Streamline and Performance Advisor to generate a machine-readable JSON report. You can import data from the JSON report into other QA test reporting systems, allowing automated regression tracking of in-depth workload metrics. See [Chapter 4 Running Performance Advisor in continuous integration workflows](#) on page 4-31 for more information.

The APC data file that the CI workflow creates is a full Streamline capture that you can import into the Streamline GUI. Arm recommends that you store the APC data file alongside other build artifacts. If Performance Advisor reports a problem, it is then immediately available for manual investigation in Streamline.

For more information about using Streamline for profiling graphical applications running on Mali GPUs, see the Arm Community blog [Accelerating Mali GPU Analysis using Arm Mobile Studio](#).

Using Streamline and Graphics Analyzer for further deep-dive analysis

The Performance Advisor report shows where your application is causing a problem. You can then use the other tools in Arm Mobile Studio suite to investigate any problems in more detail.

Streamline

Capture a profile of your application running on a mobile device and see where your system spends most of its time. Use interactive charts and comprehensive data visualizations to identify whether CPU processing or GPU rendering are causing any performance bottlenecks.

Graphics Analyzer

Graphics Analyzer enables you to evaluate all the OpenGL ES or Vulkan API calls your application makes, as it runs on an Android device. Explore the scenes in your game frame-by-frame, draw call-by-draw call, to identify rendering defects, or opportunities to optimize performance. For more information, see [Graphics Analyzer](#) on our Developer site.

Chapter 2

Before you begin

Set up Arm Mobile Studio and integrate Performance Advisor with your application by following the steps in this section.

It contains the following sections:

- [2.1 Set up your host machine on page 2-17.](#)
- [2.2 Set up your device on page 2-18.](#)
- [2.3 Integrate Performance Advisor with your application on page 2-19.](#)

2.1 Set up your host machine

To use Performance Advisor, download and install the Arm Mobile Studio suite, then install the necessary software and set up environment variables on your host machine.

Procedure

1. Download Arm Mobile Studio from <http://developer.arm.com/mobile-studio/downloads>.
2. Install Arm Mobile Studio using the instructions at <https://developer.arm.com/mobile-studio/install>.
3. Install Python 3.6 (or higher). Arm Mobile Studio uses Python to run the provided `lwi_me.py` and `gator_me.py` script, which uses the `gator` agent to connect Streamline to your Android target.
4. Install Android Debug Bridge (adb). Arm Mobile Studio uses the `adb` utility to connect to the target device. Download the latest version of `adb` from the Android SDK platform tools (<https://developer.android.com/studio/releases/platform-tools.html>).
5. Edit your `PATH` environment variable to add the paths to the Performance Advisor, Python3, and Android SDK platform tools directories.

Next Steps

See [2.2 Set up your device on page 2-18](#) for information about preparing your device for profiling your application.

2.2 Set up your device

To use Performance Advisor, set up your device with the application you want to profile.

Note

A list of the recommended devices that support Arm Mobile Studio is available from <https://developer.arm.com/mobile-studio/devices>.

Procedure

1. Set your device to *Developer Mode*.
2. Select **Settings** > **Developer options** and enable **USB debugging**.
3. Connect the device to the host machine through USB. If the connection is successful, running the `adb devices` command on the host returns your device ID:

```
adb devices
List of devices attached
ce12345abcdf1a1234    device
```

4. For devices running Android 9 or earlier, you need to add a library file to your application, to enable Performance Advisor to collect frame rate and graphics API call counts. See [2.3 Integrate Performance Advisor with your application on page 2-19](#) for instructions on how to do this.
5. Install a debuggable build of your application on the device:
 - If you are not using Unity, enable the `android:debuggable` setting in the application manifest file, as described in <https://developer.android.com/guide/topics/manifest/application-element>.
 - In Unity, when building your application, select the **Development Build** option in **Build Settings**.

Next Steps

[3.1 Connect Streamline to your device on page 3-25](#)

2.3 Integrate Performance Advisor with your application

For devices running Android 9 or earlier, package the lightweight interceptor library (LWI) with your application. Performance Advisor uses the LWI to collect performance data, such as frame rate and API call counts, from your application.

For devices running Android 10 or later, you do not need to package the library file with your application. Instead use the `--lwi-gles-layer-lib-path` or `--lwi-vk-layer-lib-path` options to specify the layer library file when you [connect Streamline to your device on page 3-25](#).

The LWI enables you to capture performance data automatically from your application, such as frame rate and frame captures. It is a lighter version of the Graphics Analyzer interceptor.

The LWI enables you to automatically capture data in the following situations:

- To automatically detect frame boundaries, or other API statistics, instead of manually embedding frame markers into the application.
- To identify slow parts of your application, you can capture a screenshot when your application goes below a threshold value that you configure.

Note

If you want to analyze your application with Graphics Analyzer, you must use a different library file, packaged in the same way as the LWI.

- For Unity applications, see [Prepare your Unity application](#).
- For applications not using Unity, see [Getting started with Graphics Analyzer](#).

If you intend to capture frames when the frame rate goes below a specified value, you must use the LWI instead.

OpenGL ES

For OpenGL ES applications, package the required library file `libMGD.so`, which is provided in your Arm Mobile Studio package:

```
<install_directory>/performance_advisor/lwi/target/android/arm/unrooted/
```

Two versions of the library are provided:

- For 64-bit targets, use the library file located in the `arm64-v8a` directory.
- For 32-bit targets, use the library file located in the `armeabi-v7a` directory.

Note

You can package one or both interceptor libraries depending on the requirements of your application.

Vulkan

For Vulkan applications, package the required Vulkan layer file, which is provided in your Arm Mobile Studio package:

```
<install_directory>/performance_advisor/lwi/target/android/arm/rooted/
```

Note

If your target device is running Android 9 or above, you do not need to package the Vulkan layer with the application. Instead specify the path to the Vulkan layer when running the target connection script.

Two versions of the library are provided:

- For 64-bit targets, use the library file located in the `arm64-v8a` directory.
- For 32-bit targets, use the library file located in the `armeabi-v7a` directory.

Next steps

Continue with the appropriate instructions for your project:

- [2.3.1 Prepare your Unity project on page 2-20](#)
- [2.3.2 Prepare your Android Studio project on page 2-23](#)

2.3.1 Prepare your Unity project

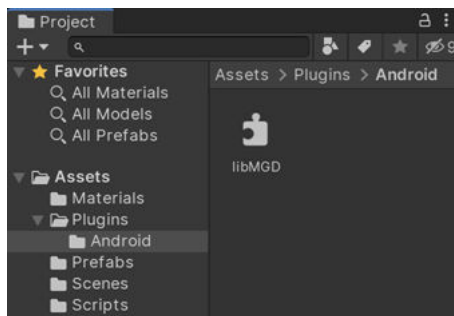
Copy the library file or Vulkan layer file into Unity, and set the necessary attributes and settings. Then build your APK and install it on your device. You are then ready to perform a capture.

Prerequisites

Locate the required library file or Vulkan layer file, as described in [2.3 Integrate Performance Advisor with your application on page 2-19](#).

Procedure

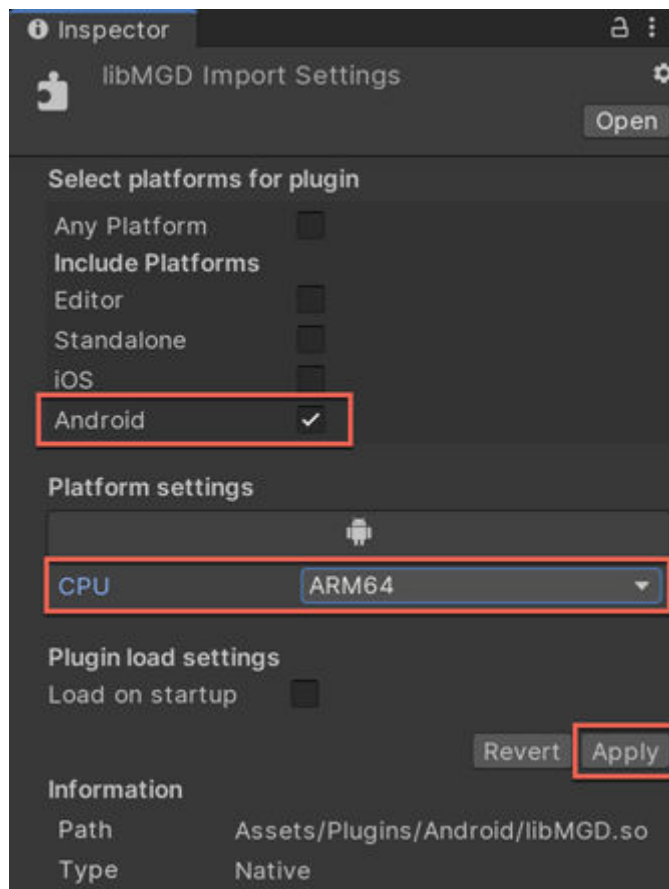
1. Copy the required libMGD.so file or Vulkan layer into the Assets/Plugins/Android/ directory in your Unity project. Create this directory if it does not exist.



If you are packaging both interceptor libraries:

- Create two directories in the Assets/Plugins/ directory. For example, armv7 and armv8.
 - Create a directory called Android in each of these directories.
 - Copy each libMGD.so file into the appropriate Android directory.
2. Select the library in Unity and set the following attributes in the Inspector:
 - Under **Select platforms for plugin**, select **Android**.
 - Under **Platform settings**, set the CPU architecture to **ARM64** for 64-bit applications, or **ARMv7** for 32-bit applications.

Click **Apply**.

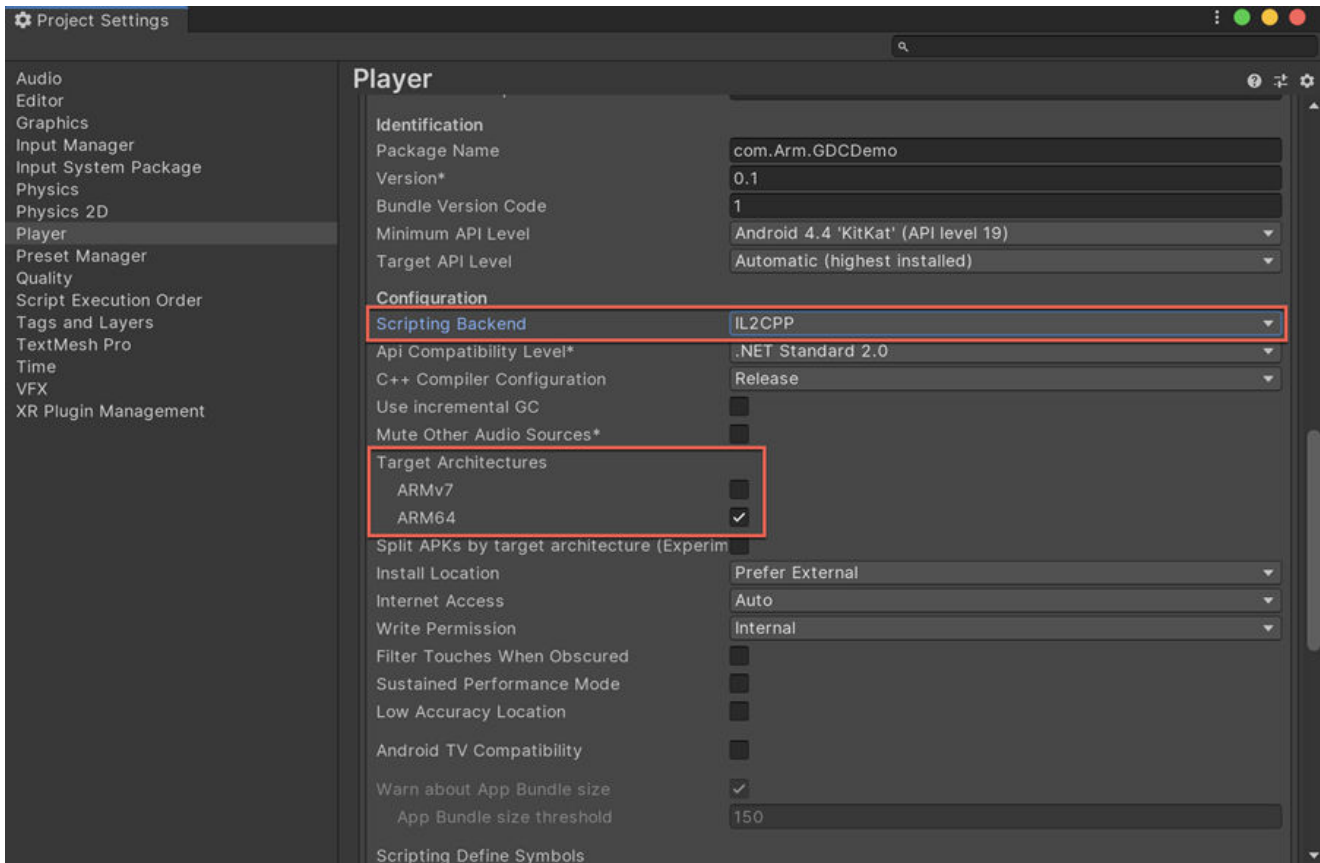


3. Select **File > Build Settings**, then select **Player Settings**.
4. Under **Identification**, set **Target API Level** to the required Android version.

————— **Note** —————

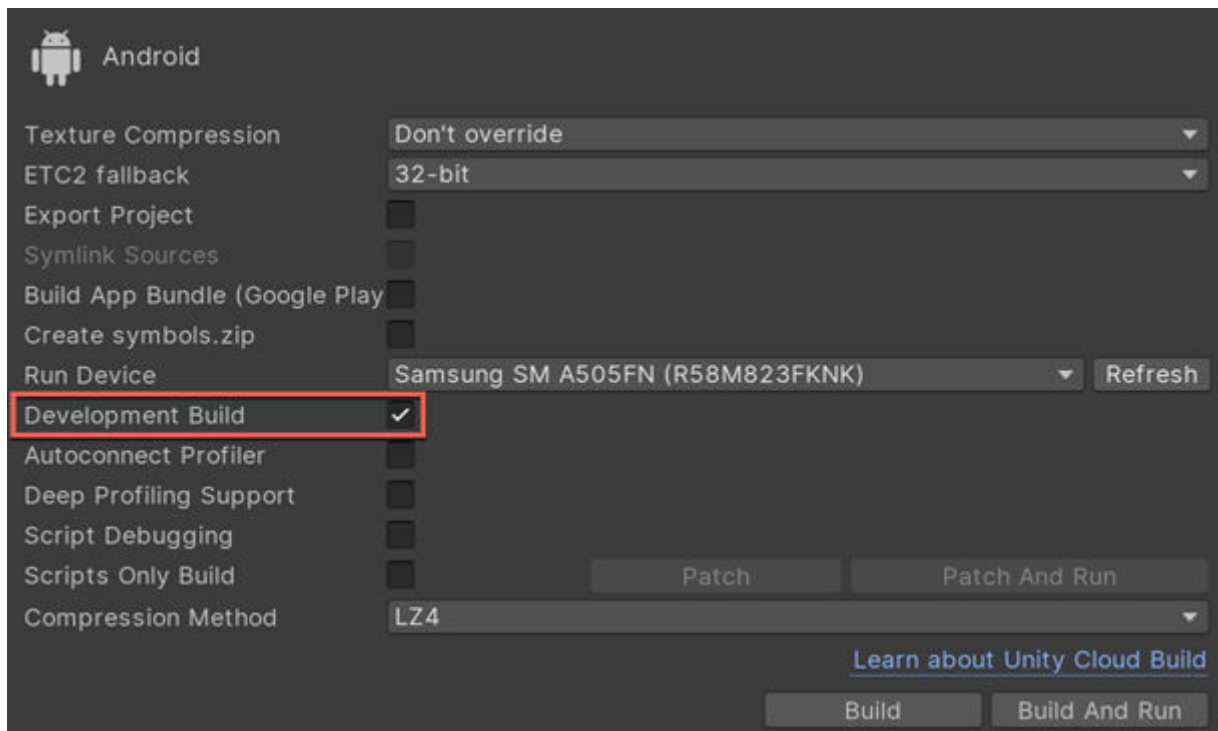
By default, **Target API Level** is set to the latest version of the Android SDK tools that you have installed. If you change to a lower API level, ensure that you have the SDK tools for that version installed. If you build for a higher API version later, change this setting accordingly.

5. Under **Configuration**, set the following options to build a 64-bit application:
 1. Set the scripting backend in Unity to work with 64-bit targets. Set **Scripting Backend** to **IL2CPP**. For more information about IL2CPP, refer to the Unity documentation.
 2. Under **Target Architectures**, select **ARM64**.



To build a 32-bit application:

1. Leave the scripting backend at its default setting, **Mono**.
2. Under **Target Architectures**, select **ARM7**.
6. Close the **Player Settings**. In the **Build Settings**, select the **Development Build** checkbox. This option ensures that your application is marked as debuggable in the Android application manifest.



7. To build your APK and install it on your device in one step, select **Build and Run**. Alternatively, select **Build** to build the APK and then install it on your device using Android Debug Bridge:

```
adb install -r YourApplication.apk
```

Next Steps

Perform an interactive capture, see [3.1 Connect Streamline to your device on page 3-25](#).

2.3.2 Prepare your Android Studio project

Supply the path to the library file or Vulkan layer file, and load the library in your code. Then build your APK and install it on your device. You are then ready to perform a capture.

Prerequisites

Locate the required library file or Vulkan layer file, as described in [2.3 Integrate Performance Advisor with your application on page 2-19](#).

Procedure

1. Supply the path to the LWI library or Vulkan layer files in your applications gradle file.
 - For OpenGL ES applications, supply the path to the LWI library in your applications gradle file:

```
android {
    sourceSets {
        main {
            jniLibs.srcDirs += 'install_directory/performance_advisor/lwi/target/
android/arm/unrooted/'
        }
    }
}
```

- For Vulkan applications, supply the path to the Vulkan layer files in your applications gradle file:

```
android {
    sourceSets {
        main {
            jniLibs.srcDirs += '<install_directory>/performance_advisor/lwi/target/
android/arm/rooted/'
        }
    }
}
```

2. Load the library in a static block in your code:

```
static
{
    try
    {
        System.loadLibrary("LWI");
    }
    catch (UnsatisfiedLinkError e)
    { ... }
}
```

3. Build your APK and install it on your device.

Next Steps

Perform an interactive capture, see [3.1 Connect Streamline to your device on page 3-25](#).

Chapter 3

Quick start guide

Performance Advisor runs on a capture file generated from Streamline. Follow the steps in this section when you are ready to perform an interactive capture.

Note

If you already have the capture files, you can go straight to [3.4 Generate a performance report on page 3-29](#).

You can also watch a demonstration of the steps on the *Android profiling with Performance Advisor* video on [YouTube](#) or [Youku](#).

It contains the following sections:

- [3.1 Connect Streamline to your device on page 3-25](#).
- [3.2 Choose a counter template on page 3-27](#).
- [3.3 Capture a Streamline profile on page 3-28](#).
- [3.4 Generate a performance report on page 3-29](#).

3.1 Connect Streamline to your device

Arm provides a Python script, `lwi_me.py` that makes connecting to your device easy. Run the script so that Streamline can connect to your device, and collect data.

Procedure

1. Open a command terminal on your host machine and navigate to the Performance Advisor installation directory, `<install_directory>/performance_advisor/lwi/helpers`.
2. Run the `lwi_me.py` Python script:

```
python3 lwi_me.py --daemon <path_to_gatord> \
--lwi-out-dir <path_to_empty_directory> \
[--lwi-gles-layer-lib-path | --lwi-vk-layer-lib-path \
<path_to_Android10_layer_lib>]
```

Use the `--daemon` option to specify the path to the `gatord` binary that you want to install on your device to collect data. This file is provided in your installation directory in two versions:

- For 32-bit applications, use `<install_directory>/streamline/bin/arm/gatord`.
- For 64-bit applications, use `<install_directory>/streamline/bin/arm64/gatord`.

Use `--lwi-out-dir` to specify an empty directory to save frame capture images.

For Android 10, use `--lwi-gles-layer-lib-path` or `--lwi-vk-layer-lib-path` to specify the path to the OpenGL ES or Vulkan layer library file for Android 10 devices. These files are provided in your installation directory. Libraries for both 32-bit and 64-bit applications are stored in different folders; `armeabi-v7a` for 32-bit applications, and `arm64-v8a` for 64-bit applications.

- The Open GL ES layer library file `libGLES_layer_lwi.so` is located in: `<install_directory>/performance_advisor/lwi/target/android/arm/unrooted/{arm64-v8a|armeabi-v7a}/libGLES_layer_lwi.so`
- The Vulkan layer library file `libVkLayerLWI64.so` is located in: `<install_directory>/performance_advisor/lwi/target/android/arm/rooted/{arm64-v8a|armeabi-v7a}/libVkLayerLWI64.so`

For example:

```
python3 lwi_me.py --daemon ../../streamline/bin/arm64/gatord \
--lwi-out-dir $HOME/Documents/frame_captures --lwi-gles-layer-lib-path \
../target/android/arm/unrooted/arm64-v8a/libGLES_layer_lwi.so
```

3. The script returns a numbered list of the Android package names for the debuggable applications that are installed on your device. Enter the number of the package you want to profile.

The script identifies the GPU in the device, installs the daemon application, and waits for you to complete the capture in Streamline. Leave the terminal window open, as you will need to come back to it later to terminate the script.

4. Launch Streamline:

- On Windows, from the **Start** menu, navigate to **Arm MS 2020.1** and select **Arm MS Streamline 2020.1**.
- On macOS, go to the `<install_directory>/streamline` folder, and double-click the `Streamline.app` file.
- On Linux, go to the `<install_directory>/streamline` folder, and run the Streamline file:

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

5. In the **Target** view, click  and select your device.



Next Steps

Choose a counter template. For more information about how to find and select a counter template, see [3.2 Choose a counter template on page 3-27](#).

3.2 Choose a counter template

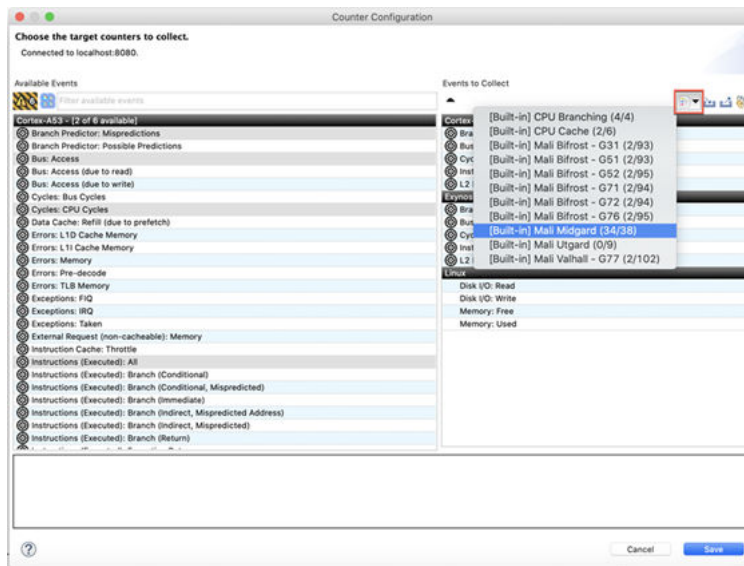
Counter templates are pre-defined sets of counters that enable you to review the performance of both CPU and GPU behavior. Choose the most appropriate template for the GPU in your target device.

Prerequisites

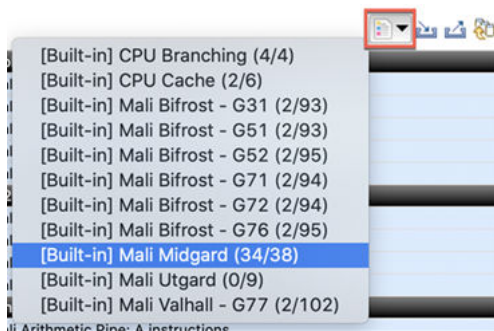
Follow the instructions detailed in [Connect Streamline to your device on page 3-25](#) before you choose your counter template.


Procedure

1. To choose a counter template, in **Target** view, click **Counter configuration** .
2. Click **Add counters from a template**  to see a list of available templates.



3. Select a counter template appropriate for the GPU in your target device, then **Save** your changes.
The number of counters in the template that your target device supports is shown next to each template. Choose the template with the highest number of supported counters. For example, here, 34 of the 38 available counters in the Mali Midgard template are supported in the connected device.



4. Optionally, in **Target** view, click **Capture & analysis options**  to set more capture options, including the sample rate and the capture duration (by default unlimited). Refer to [Capture options](#) in the *Arm Streamline User Guide*.

Next Steps

Capture a profile using Arm Streamline. For more information about how to capture the behavior of your CPU and GPU performance using Arm Streamline, see [3.3 Capture a Streamline profile on page 3-28](#).


3.3 Capture a Streamline profile

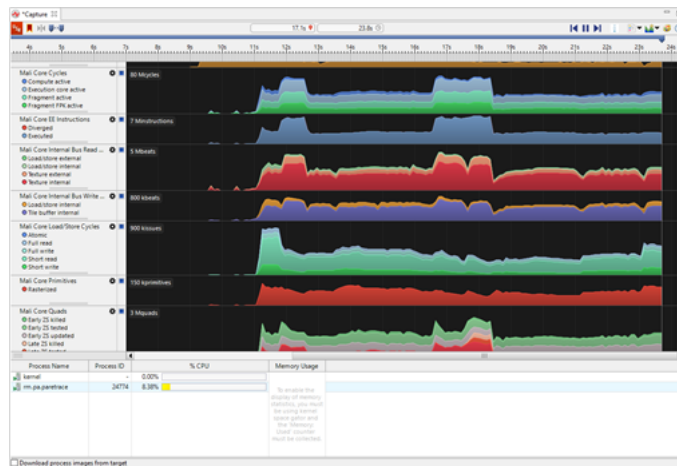
Start a capture session to profile data from your application in real time. When the capture session ends, Streamline automatically opens a report for you to analyze later.


Prerequisites

Before you capture a profile in Streamline, you must [Connect Streamline to your device on page 3-25](#) and [3.2 Choose a counter template on page 3-27](#).

Procedure

1. Click **Start Capture**  to start capturing data from the target device.
Specify the name and location on the host for the capture file that Streamline creates when the capture is complete. Streamline then switches to Live view and waits for you to start the application on the device.
2. Start the application that you want to profile.
Live view shows charts for each counter that you selected. Below the charts is a list of running processes in your application with their CPU usage. The charts now start updating in real time to show the data that **gator**d captures from your running application.



3. Unless you specified a capture duration, click **Stop capture**  to end the capture.
Streamline stores the capture file in the location that you specified previously, and then prepares the capture for analysis. When complete, the capture appears in the **Timeline** view.
4. **IMPORTANT:** Switch back to the terminal running the `lwi_me.py` script and press any key to terminate it. The script kills all processes that it started and removes **gator**d from the target.

Next Steps

- [Generate a performance report on page 3-29](#)
- To analyze performance with Streamline, see [Analyze your capture](#) in the *Arm Streamline User Guide*.

3.4 Generate a performance report

Generate an HTML performance report from an existing Streamline capture.

Prerequisites

To generate a report, you must first [Connect Streamline to your device on page 3-25](#), [3.2 Choose a counter template on page 3-27](#), and [3.3 Capture a Streamline profile on page 3-28](#).

Procedure

1. Open a terminal in the directory containing your APC file.

Note

The APC file can be a zip file or an uncompressed .apc directory.

2. Run Performance Advisor using the following command:

```
pa <filename>.apc [options]
```

To control how the pa command runs, you can pass various options to it. See [B.1 The pa command on page Appx-B-49](#) for detailed descriptions of all the available options.

Note

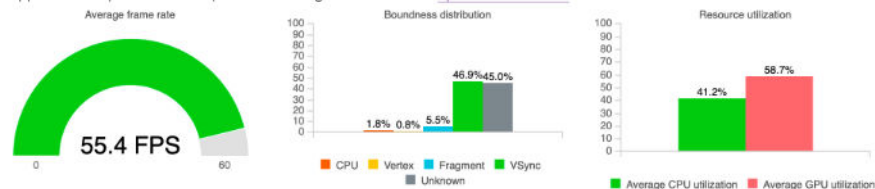
- For example, to include build and device information in the report summary, include the --build-name, --build-timestamp, and --device-name command-line options.
- To show any CPU and GPU scheduling issues with your application, include the --main-thread option and specify the thread that you want to analyze:

```
--main-thread <thread-name>
```

Performance Advisor shows an indicator at the top of the report if any scheduling issues are detected.

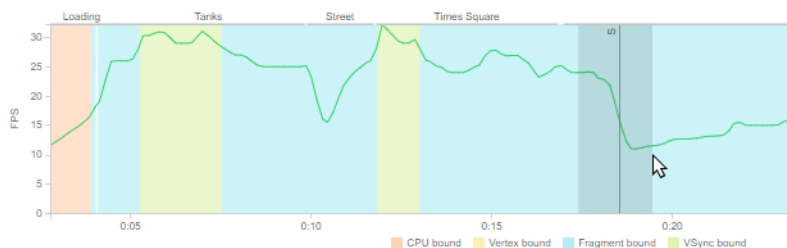
Capture summary ⓘ

- ⚠ Your application may contain CPU-GPU scheduling issues. Read our [optimization advice](#).
- ⚠ Your application may contain GPU queue scheduling issues. Read our [optimization advice](#).



Performance Advisor saves an HTML file to the current directory. Alternatively, you can specify a different directory using the --directory option. The file contains the results of the performance analysis, and links to advice on how to improve the performance.

The summary section shown at the top of the report is based on the duration of your capture. To take a closer look at a specific area of interest, click and drag the cursor over the region to select it.



Click anywhere on the chart when you are ready to go back to the original capture duration.

You can zoom in to any line chart in the report in the same way, by clicking and dragging over the area of interest. When you zoom in on one chart, all other charts in the same section zoom in to the same point so you can easily compare them.

To get help on overcoming graphics problems and optimizing your application, click the [advice links](#) on the report.

Related tasks

[4.2 Export performance data as a JSON file on page 4-33](#)

[4.3 Generate multiple report types on page 4-36](#)

Related references

[B.1 The pa command on page Appx-B-49](#)

Related information

[Optimization advice for mobile applications](#)

Chapter 4

Running Performance Advisor in continuous integration workflows

Regular performance reports enable you to get instant feedback throughout your development cycle. With an Arm Mobile Studio Professional license, you can integrate Performance Advisor into your continuous integration workflow. This workflow enables you to automatically generate daily reports that help your team monitor how changes during the development cycle impact performance. Also, you can automatically generate machine-readable JSON reports that you can import into your existing performance regression tracking systems.

It contains the following sections:

- [4.1 Generate a headless capture on page 4-32.](#)
- [4.2 Export performance data as a JSON file on page 4-33.](#)
- [4.3 Generate multiple report types on page 4-36.](#)

4.1 Generate a headless capture

Generate a performance report without using the Streamline GUI to take a capture.

Prerequisites

Generate a `configuration.xml` file by performing one manual capture on the target device, as described in [Chapter 3 Quick start guide on page 3-24](#), and saving a configuration file, as described in the [Streamline user guide](#).

Procedure

1. Open a terminal and change to the `<installation_directory>/performance_advisor/lwi/helpers` directory.
2. Run the `lwi_me.py` script with the `--headless` option, and specify the path to the configuration file:

```
python3 lwi_me.py --lwi-out-dir <path_to_output_directory> \  
--package <app.package.name> \  
--headless <path_to_directory>/<filename>.apc \  
--daemon <install_directory>/streamline/bin/arm64/gatord \  
--config <path_to_config_file>/configuration.xml
```

This command pushes `gatord` onto the target, ready to profile the target application.

3. When the script prints a prompt to do so, start the application on the target device.
4. To stop profiling, exit the application in one of the following ways:
 - Exit the application at the end of the test scenario.
 - Manually exit the application using the Android user interface.
 - Forcefully kill the application using:

```
adb shell am force-stop <app.package.name>
```

The script downloads the capture data to the host machine path specified by the `--headless` command-line option.

Note

Instead of exiting the application, you can specify a `--headless-timeout <seconds>` value. This method is not ideal for test scenarios with variable performance.

4.2 Export performance data as a JSON file

Generate a JSON report that you can import into other tools. Use reports from multiple test runs to track performance over time.

Note

JSON reports are only available with an Arm Mobile Studio Professional license.

JSON reports provide a raw data export that you can import into other tools, such as a NoSQL database, to compare different test runs. For example, you can track the average number of visible primitives per frame between builds.

Procedure

1. Open a terminal in the directory containing your APC file.

Note

The APC file can be a zip file or an uncompressed .apc directory.

2. Run Performance Advisor using the following command:

```
pa <capture.apc.zip> -p <app.package.name> -d <optional output dir> -t json
```

To change the output file name, append it to the -t argument using a colon:

```
-t json:your_file_name.json
```

The following example shows part of a JSON report:

```
{
  "deviceInfo": {
    "build": null,
    "device": "Example board",
    "processors": "Cortex-A55 MP4, Mali-G72"
  },
  "allCapture": {
    "averageFrameRateFps": 19.4,
    "boundnessSplitPercentage": {
      "fragment": 0.0,
      "vertex": 0.0,
      "vsync": 0.0,
      "cpu": 98.5,
      "unknown": 1.5
    },
    "averageUtilizationPercentage": {
      "averageGpuUtilization": 19.0,
      "averageCpuUtilization": 62.7
    }
  },
  "fpsBoundness": {
    "frameRate": {
      "average": 19.4,
      "max": 21.1,
      "min": 17.9,
      "centiles": {
        "80": 20.0,
        "98": 21.1,
        "95": 20.7
      }
    },
    "vsync": {
      "target": 60,
      "percentageTimeUnderTarget": 100
    }
  },
  "overdrawPerPixel": {
    "overdraw": {
      "average": 0.3,
      "max": 0.4,
      "min": 0.1,
      "centiles": {
```

```

        "80": 0.4,
        "98": 0.4,
        "95": 0.4
    }
},
"gpuUsagePerFrame": {
    "vertexCycles": {
        "average": 1707767.6,
        "max": 2039630.8,
        "min": 770117.5,
        "centiles": {
            "80": 1917112.6,
            "98": 2039630.8,
            "95": 2039630.8
        }
    },
    "gpuCycles": {
        "average": 4157114.0,
        "max": 4897026.6,
        "min": 1587167.6,
        "centiles": {
            "80": 4649032.8,
            "98": 4897026.6,
            "95": 4897026.6
        }
    },
    "fragmentCycles": {
        "average": 2449346.8,
        "max": 2911080.0,
        "min": 608306.8,
        "centiles": {
            "80": 2857394.4,
            "98": 2911080.0,
            "95": 2911080.0
        }
    }
},
"drawCallsPerFrame": {
    "drawCalls": {
        "average": 456.0,
        "max": 456.0,
        "min": 456.0,
        "centiles": {
            "80": 456.0,
            "98": 456.0,
            "95": 456.0
        }
    }
},
"primitivesPerFrame": {
    "totalPrimitives": {
        "average": 290318.2,
        "max": 331233.8,
        "min": 114309.3,
        "centiles": {
            "80": 325304.5,
            "98": 331233.8,
            "95": 331233.8
        }
    },
    "visiblePrimitives": {
        "average": 89856.7,
        "max": 102210.2,
        "min": 34685.2,
        "centiles": {
            "80": 100151.9,
            "98": 102210.2,
            "95": 102210.2
        }
    }
},
"pixelsPerFrame": {
    "pixels": {
        "average": 4669783.4,
        "max": 5315129.7,
        "min": 3197000.8,
        "centiles": {
            "80": 5165539.5,
            "98": 5315129.7,
            "95": 5315129.7
        }
    }
}
}

```

```
... },
```

Related tasks

3.4 Generate a performance report on page 3-29

4.3 Generate multiple report types on page 4-36

Related references

B.1 The pa command on page Appx-B-49

4.3 Generate multiple report types

Generate an HTML performance report and a JSON performance report from an existing Streamline capture.

Prerequisites

Before you can generate a report, you must have a Streamline capture file. For help on creating a capture, see [3.3 Capture a Streamline profile on page 3-28](#).

Procedure

1. Open a terminal in the directory containing your APC file.

————— **Note** —————

The APC file can be a zip file or an uncompressed .apc directory.

2. Run Performance Advisor using the following command:

```
pa <capture.apc.zip> -p <app.package.name> -d <optional output dir> -t html,json
```

To change the output file names, append each file name to the corresponding type argument using a colon:

```
-t html:your_file_name.html,json:your_file_name.json
```

Related tasks

[3.4 Generate a performance report on page 3-29](#)

[4.2 Export performance data as a JSON file on page 4-33](#)

Related references

[B.1 The pa command on page Appx-B-49](#)

Chapter 5

Capturing a slow frame

Identify slow frames by using the lightweight interceptor (LWI) in different modes. Before you can use the LWI, you must first integrate it with your application.

It contains the following sections:

- [5.1 Capturing slow frame rate images on page 5-38.](#)
- [5.2 Tagging slow frames on page 5-40.](#)

5.1 Capturing slow frame rate images

Use Performance Advisor to continuously monitor frame rate and trigger frame captures when a slow part is detected.

Arm provides the helper script `lwi_me.py` to enable you to capture data from your device using the lightweight interceptor. This script is located in `<install_directory>/performance_advisor/lwi/helpers`.

Procedure

1. Create an empty directory for the frame capture images.
2. In a terminal, navigate to `<install_directory>/performance_advisor/lwi/helpers`, where the Python script `lwi_me.py` is located.
3. Run the `lwi_me.py` script with the options you need for your frame capture.

The script configures your device so that Performance Advisor can collect data from it. Specify the directory you created in step 1 so the frame capture images are saved there.

————— Note —————

This directory must be empty.

For example, to capture a frame when the frame rate goes below 30fps, and allow at least 100 frames between captures:

```
python3 lwi_me.py --daemon <path_to_gatord> --lwi on --lwi-fps-threshold 30 \
--lwi-frame-gap 100 --lwi-out-dir <path_to_frame_captures_directory> \
[--lwi-gles-layer-lib-path <path_to_GLES_layer_lib>]
```

The `gatord` binaries are in the Arm Mobile Studio installation directory:

- For 32-bit applications, set `--daemon` to `<install_directory>/streamline/bin/arm/gatord`
- For 64-bit applications, set `--daemon` to `<install_directory>/streamline/bin/arm64/gatord`

The `--lwi-gles-layer-lib-path` option is required for Android 10 devices to specify the path to the OpenGL ES layer library file. This file is supplied in the Arm Mobile Studio installation directory. For example:

```
--lwi-gles-layer-lib-path \
../target/android/arm/unrooted/arm64-v8a/libGLES_layer_lwi.so
```

See [B.2 The `lwi_me.py` script options](#) on page [Appx-B-51](#) for details of all the available command-line options.

————— Note —————

Capturing frames can affect performance. If you notice a decrease in performance when capturing images, tag the slow frames instead. See [5.2 Tagging slow frames](#) on page [5-40](#) for more information.

4. If there are multiple debuggable packages on your device, the script lists them. Enter the number of the package you want to analyze and follow the instructions to take a Streamline capture, as described in [3.3 Capture a Streamline profile](#) on page [3-28](#).

You do not need to run the `gator_me` script as it is called by the `lwi_me` script.

Important

When Streamline prompts you to save the capture file, do not save it to the frame captures directory that you specified in step 1. The contents of this directory are replaced when the frame capture images are written there.

Note

During the capture, images are saved to the output directory every time the FPS drops below the target threshold. By default, images stop being captured after the first 500 frames. You can adjust the end frame by specifying a different number using the `-lwi-frame-end` option when running the `lwi_me.py` script. You can also specify the frame number at which to start the capture, using the `-lwi-frame-start` option.


5. Use the `pa` command to generate an HTML report, specifying the location where you saved the frame capture images in step 1. Optionally specify a directory in which to save the HTML report, otherwise the HTML report is saved to the current directory.

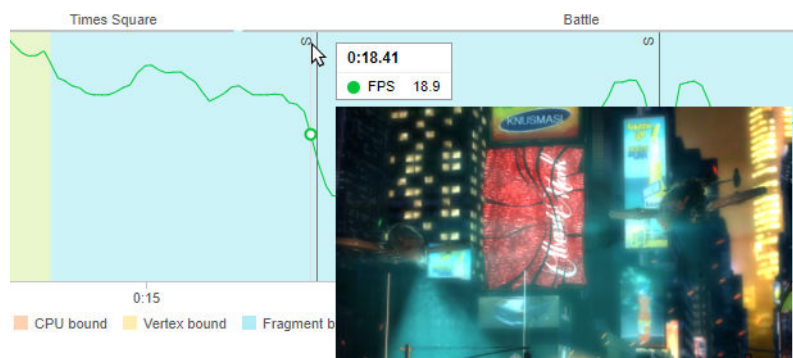
```
pa <my_capture.apc> --frame-capture=<path_to_frame_captures_directory> \
[--directory=<path_to_output_directory>]
```

You can use other options to specify metadata for your report, such as the build name, device name, and application name. See [B.1 The `pa` command on page Appx-B-49](#) for all the available command-line options.

For more information about generating an HTML report, see [Generate multiple report types on page 4-36](#).

6. Open the HTML report in a browser.

To see the captured frame, hover the cursor over the screen capture icon .



5.2 Tagging slow frames

If capturing frames directly impacts the performance of your application by reducing the frame rate, run the `lwi_me.py` command to capture the frame numbers in tag mode. Then run the `lwi_me.py` command to capture the frames in replay mode.

Procedure

1. Trace your application and output the capture to a specified folder.

For example, use the following command to trace an OpenGL ES application, tagging a frame when the frame rate goes below 50fps:

```
python3 lwi_me.py --daemon <path to gator> --package <app.package.name> --lwi on \
--lwi-fps-threshold 50 --lwi-mode tag --lwi-out-dir /some/folder
```

Run the file with tagged frame numbers using `--lwi-mode replay` to capture the tagged frames.

```
python3 lwi_me.py --daemon <path to gator> --package <app.package.name> --lwi on \
--lwi-fps-threshold 50 --lwi-mode replay --lwi-slow-frames /some/folder/slow-frames \
--lwi-out-dir /some/folder
```

2. Manually capture a Streamline profile, as described in [3.3 Capture a Streamline profile on page 3-28](#).


————— Note —————

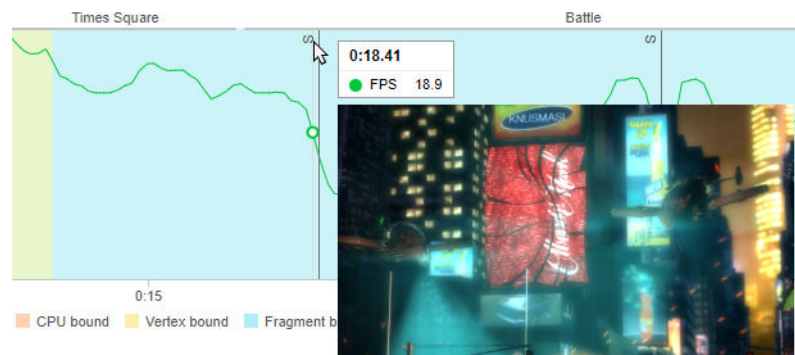
During the Streamline capture, the captured resources are written in the target when the trace reaches the end frame. The default is to end the capture at frame 500. You can adjust the end frame by specifying an alternative value for the `FRAMEEND` parameter of the `lwi_me.py` script.

3. To export the capture to the HTML report, send the frame capture path to the output directory:

```
pa [capture.apc] --package <app.package.name> --frame-capture=path [frame_capture_folder]
```

For more information about generating an HTML report, see [4.3 Generate multiple report types on page 4-36](#).

To see the captured frame, hover the cursor over the screen capture icon .



Chapter 6

Adding semantic input to the reports

Performance Advisor can use semantic information that the application provides as key input data when generating the analysis reports.

The analysis reports support the use of region annotations to give context to the different frame ranges in a test scenario. Manually add these annotations into the application code. Alternatively, if manually adding annotations is not possible, or for quick debugging and extra analysis, specify a CSV file containing the regions. Give Performance Advisor the path to the CSV file using the `--regions` argument.

It contains the following sections:

- [*6.1 Manually create annotations from your application*](#) on page 6-42.
- [*6.2 Specify a CSV file containing the regions*](#) on page 6-44.
- [*6.3 Clip unwanted data from the capture*](#) on page 6-45.

6.1 Manually create annotations from your application

Streamline allows an application to manually create annotations, which can be used as an alternative source of frame boundary annotations.

Note

If you are hand-coding Performance Advisor annotations, use the `gator_me.py` script instead of `lwi_me.py` script. The script is located in the Arm Mobile Studio installation directory:
<install_directory>/performance_advisor/lwi/helpers/

Native code

The native C code to include for generating annotations is located in the <ms_install>/streamline/gator/annotate/ directory.

Unity plug-in code

Source code for a proof-of-concept plug-in for Unity 2018.2, which provides C# bindings for the Streamline annotation functions, is located here:

[\[GitHub\] ARM-software Mobile Studio Unity Plugin](#)

6.1.1 Generating frame boundary annotations

The Graphics Analyzer interceptor automatically adds frame boundary annotations. However, for more flexibility over how the frames are defined, you can manually specify the annotations. For example, if you only want to track certain frames or if you have multiple contexts.

To implement frame boundary annotations manually, generate Streamline marker annotations matching the following regular expression format, where the number is a monotonically incrementing frame number:

```
F(/d+)
```

For example:

```
F10  
F11  
F12
```

6.1.2 Generating region annotations

Region annotations enable you to define consecutive frames as a named group to help you see which part of your application is running when you review its performance. Performance Advisor produces a separate section in the report for each defined region so that you can analyze the metrics for each region in more detail.

To define a region in your code, manually generate Streamline marker annotations:

```
Region Start <region name>  
Region End <region name>
```

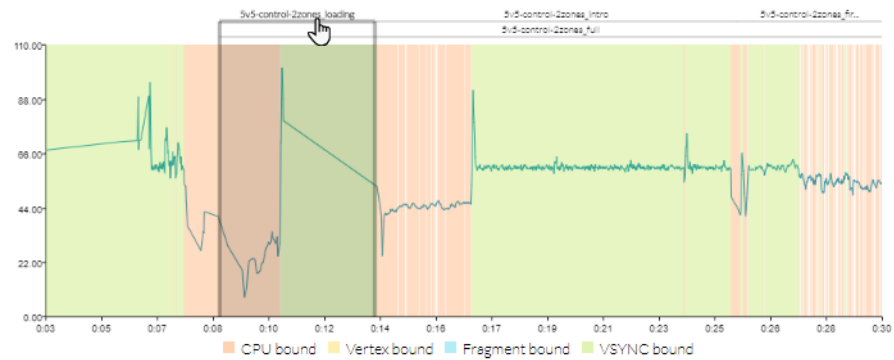
Note

To prevent an error, ensure that region names are unique by appending a number to the end of the region name.

To ensure that conclusions are statistically significant, Arm recommends keeping regions and subregions relatively large. For example, at least two seconds in length.

The regions defined in your code are shown on the **FPS analysis** chart. Any regions that overlap are shown as subregions on the chart.

FPS analysis ⓘ

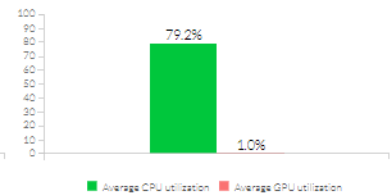
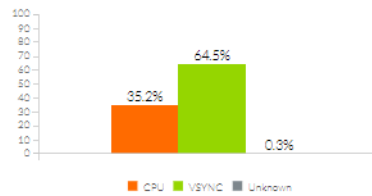
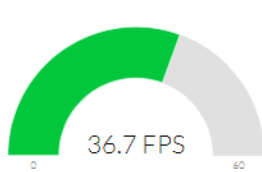


Click a region to zoom in and analyze it further on the **FPS analysis** chart, or scroll down the report to see metrics for each region.

5v5-control-2zones_loading (0:08 - 0:13)

Summary

⚙️ This region is mainly hitting VSync, this indicates that it is performing well.



6.2 Specify a CSV file containing the regions

If manually adding annotations is not possible, or for quick debugging and extra analysis, specify a CSV file containing the regions and use the `--regions` argument.

Create a CSV file using the following format, where each region is on a new line:

```
Region Name,Start Time (ms),End Time (ms)
```

For example:

```
Test Region,0,1000
```

————— **Note** —————

Do not put spaces next to the commas.

Give Performance Advisor the path to the CSV file using the `--regions` argument.

6.3 Clip unwanted data from the capture

Specify the part of the capture that you want to include in the analysis report and discard the remaining data. For example, remove the loading and ending screens so they are not included in the report.

You can specify the start and end time with one of the following:

- A timestamp in milliseconds.
- A region name with :start or :end appended to it.

Procedure

1. Specify the start of the report with `--clip-start=<clipStartStr>`.
If you do not specify a start, the report starts from the beginning of the capture.
2. Specify the end of the report with `--clip-end=<clipEndStr>`.
If you do not specify an end, the report ends at the end of the capture.

Example 6-1 Clip sections of a capture

-
- Clip the capture so the report starts at two seconds and ends at 15 seconds:

```
--clip-start 2000 --clip-end 15000
```
 - Clip the capture so the report starts at the end of the region named "loading screen":

```
--clip-start "loading screen:end"
```
 - Clip the capture so the report starts at the end of the region "level one loading screen" and ends at the start of the region "level two loading screen":

```
--clip-start "level one loading screen:end" --clip-end "level two loading screen:start"
```
-

Related references

[B.1 The pa command on page Appx-B-49](#)

Appendix A

Analytics

It contains the following section:

- [A.1 Analytics](#) on page Appx-A-47.

A.1 Analytics

Arm periodically collects anonymous information about the usage of our products to understand, and analyze, what components or features you are using. We use this information to improve our products and your experience with them.

Product usage analytics contain information such as system information, settings, and usage of specific features of the product.

The data that we collect through Performance Advisor is anonymous and does not include any personal information:

- Version and build number of Performance Advisor.
- Session time using Performance Advisor.
- Edition of license that you are using (Starter, Evaluation, or Professional).
- Operating system details, such as version number, platform, language, and architecture (for example 64-bit).
- Number of monitors.
- Screen pixels per inch (PPI) and monitor resolutions.
- CPU and GPU information.
- Java version and memory.
- Number, and type (HTML or JSON), of reports generated.
- Number of headless captures used.
- Number of captures containing user regions.
- Number of captures containing overdraw, or draw call information.
- Number of times screenshots were supplied.
- Total number of errors that you encountered, reported by type of error.
- Total number of licensing errors (unsupported/unknown license).
- Use of the `--mspf` option to display milliseconds per frame in the report.

Note

Analytics collection is enabled by default.

- Set the command-line argument `--disable-analytics` when running Performance Advisor to disable it for the current invocation.
 - Alternatively, set the `ARM_DISABLE_ANALYTICS` environment variable to any nonzero value before running Performance Advisor to disable analytics collection for all invocations.
-

Appendix B

Command-line options

It contains the following sections:

- [B.1 The *pa* command on page Appx-B-49.](#)
- [B.2 The *lwi_me.py* script options on page Appx-B-51.](#)

B.1 The pa command

The pa command runs Performance Advisor on a capture.

Syntax

```
pa [OPTIONS] <capture.apc>
```

Options

<capture.apc>

The path to the capture APC directory or zip file.

--centiles=int[,int...]

Comma-separated integer values specifying the percentiles to calculate for each data series.
Default = 80,90,95.

--clip-end=clipEndStr

Specify the time that you want the report to end at. clipEndStr is the timestamp in milliseconds, or is in the format <region-name>:start or <region-name>:end to use the start or end time of a region.

--clip-start=clipStartStr

Specify the time that you want the report to start from. clipEndStr is the timestamp in milliseconds, or is in the format <region-name>:start or <region-name>:end to use the start or end time of a region.

-d, --directory=path

The output directory path for the reports.

--disable-analytics

Disable sending any analytics data to Arm.

-f, --frame-capture=path

The path to the frame captures directory.

-h, --help

Show command-line arguments and descriptions, and exit.

-m, --main-thread=string

The name of the main render thread to analyze.

--mspf

Display milliseconds per frame throughout the HTML report instead of FPS.

-p, --process=string

The name of the process to inspect.

--[no-]progress

Whether to display progress bars or not.

-r, --regions=file

Takes a CSV file containing custom regions to add to the report. Expects each line of the CSV file to be of the format `regionName,startMs,endMs`. See [6.2 Specify a CSV file containing the regions on page 6-44](#).

-t, --type=type[:file][,type[:file]...]

A comma-separated list of report types, where the type is one of:

json

JSON CI report

html

Interactive html report

You can specify an output filename for each report.

--target-fps=int

The target frame rate in frames per second. Default = 60.

-V, --version

Print version information and exit.

Options for report metadata:

--application-name=string

The human readable name of the application being analyzed. For example, "Awesome Game". If the name contains whitespace, use quotes. This name becomes the report title. Default = "Performance Advisor Report".

--build-name=string

The build name of your application. For example, nightly. fa34c92.

--build-timestamp=string

The timestamp of your application build. For example, Thu, 22 Aug 2019 12:47:30.

--device-name=string

The name of the device that is used to obtain the capture.

B.2 The lwi_me.py script options

To see the possible options and their default values for the `lwi_me.py` command, run `python3 lwi_me.py -h`.

Syntax

```
python3 lwi_me.py --daemon <path_to_gatord> --lwi-out-dir <path_to_empty_directory> [OPTIONS]
```

Options

--device or -E

The target device name. If not specified, the script automatically detects the name from the device.

--package or -P

The application package name. If not specified, the script returns a list of debuggable packages on the device, and prompts you to choose one.

--headless or -H

Perform a headless capture, and write the result to a specified `<capture_path>`. Default = perform interactive capture.

--headless-timeout or -T

Exit the headless timeout after the specified number of `<seconds>`. Default = wait for process exit.

--config or -C

Specify the `<filename>` of the configuration XML file you want to use for a headless capture. Default = None for an interactive capture, or `configuration.xml` for a headless capture.

--daemon or -D

Mandatory. Specify the `<path>` to the `gatord` binary you want to use. The `gatord` binaries are supplied in the Arm Mobile Studio installation directory:

```
<install_directory>/streamline/bin/{arm|arm64}/gatord
```

Different folders contain different versions of `gatord` for 32-bit (`arm`) or 64-bit (`arm64`) applications.

--no-clean-start

Disable pre-run device cleanup. Default = enabled.

--no-clean-end

Disable post-run device cleanup. Default = enabled.

--overwrite

Overwrite an earlier headless output. Default = disabled.

--verbose or -v

Enable verbose logging. Default = disabled.

--lwi on | off | alone

Enable or disable the LWI. The `alone` mode bypasses gator. Default = `off`.

--lwi-api gles | vulkan

Select the API you want to listen to. Default = `gles`.

--lwi-gles-layer-name <name>

The OpenGL ES layer name. Default = `libGLES_layer_lwi.so`.

--lwi-gles-layer-lib-path <path>

The path to the OpenGL ES layer library file. This file is supplied in the Arm Mobile Studio installation directory:

<install_directory>/performance_advisor/lwi/target/android/arm/{rooted|unrooted}/{arm64-v8a|armeabi-v7a}/libGLES_layer_lwi.so

Different files are supplied for rooted or unrooted devices, and for 32-bit (armeabi-v7a) or 64-bit (arm64-v8a) applications.

--lwi-vk-layer-name <name>

The Vulkan layer name. Default = VK_LAYER_ARM_LWI.

--lwi-vk-layer-lib-path <path>

The Vulkan layer library path.

--lwi-fps-window or -W

Specify the <number_of_frames> for the sliding window used for FPS calculation. Default = 5.

--lwi-fps-threshold or -Th

Perform a capture if the FPS goes under a specified <fps_value>. Default = 50.

--lwi-frame-start or -S

Start tracking from a specified <frame_number>. Default = 1.

--lwi-frame-end or -N

End tracking at the specified <frame_number>. Default = 500.

--lwi-frame-gap or -G

Minimum <number_of_frames> between two captures. Default = 200.

--lwi-mode or -M

Specify in which mode you want the LWI to operate:

- **capture** or **c** to capture frame images when the fps goes below the specified --lwi-fps-threshold <fps_value>. This value is the default.
- **tag** or **t** to tag frame numbers when the fps goes below the specified --lwi-fps-threshold <fps_value>.
- **replay** or **r** to run the file of tagged frame numbers.

--lwi-slow-frames <path>

Path to a file containing the indices of slow frames (required in replay mode). Generate this file using the LWI in tag mode.

--lwi-out-dir or -o

Mandatory. Specify the <path> to the directory that the LWI captures are output to. This directory must be empty.