



RenderDoc for Arm[®] GPUs

Version 2025.7

User Guide

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RenderDoc for Arm® GPUs User Guide

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The product version is 2025.7.

See also: [Proprietary notice](#) | [Product and document information](#) | [Useful resources](#)

Start reading

If you prefer, you can skip to [the start of the content](#).

Intended audience

This document is intended for software developers who want to use RenderDoc for Arm GPUs for frame-based graphical analysis of Android and Linux applications.

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1. Introduction to Arm® RenderDoc for Arm GPUs

Arm® RenderDoc for Arm GPUs enables RenderDoc users to capture, analyze, and debug graphics applications from Windows, Linux, and Android targets. This section introduces Arm® RenderDoc for Arm GPUs and describes how it works with RenderDoc.

Overview of Arm® RenderDoc for Arm GPUs

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

Arm contributes changes to the upstream project, but some Arm-specific or Android-specific features are only available in the Arm fork.

Arm-specific features

Arm® RenderDoc for Arm GPUs is based on upstream [RenderDoc 1.41](#) and has the following extensions:

- Bundled pre-built glibc and musl binaries for remote Linux.
- Binary RenderDoc releases for developers using macOS host machines.
- Use `malioc` as a shader view tool.
- Support for capture and replay of Vulkan opacity micromaps.
- Support for libGPUCounters.
- Automatic attachment and swapchain image rotation based on swapchain pre-rotate.
- Configure Vulkan debug layers to use during capture and replay.
- Open captures remotely on Linux and Android targets.
- Support for ML extensions for Vulkan from the Arm Neural Graphic Development Kit.
- Python 3.10 UI extension support for all platforms.
- Per-region counter heatmaps for devices containing Arm Mali™-G1, or later.

Support

The following resources provide additional help and information:

| Resource | Link |
|--|---|
| RenderDoc documentation | https://renderdoc.org/docs/index.html |
| To ask a question directly, you can email the Arm® Performance Studio team | performancestudio@arm.com |
| Arm® RenderDoc for Arm GPUs on Arm Community | Graphics, Gaming, and VR community forum |



The latest version of the Arm® RenderDoc for Arm GPUs User Guide is included in each product release. The user guide version might be older than the product version because the user guide is updated only as required.

2. Get started with Arm® RenderDoc for Arm GPUs

This tutorial describes how to set up a target and capture frames for analysis with Arm® RenderDoc for Arm GPUs.

Learn how to:

- [Setup your Android target](#) to prepare your computer and Android target.
- [Setup your Linux target](#) to prepare your computer and Linux target
- [Capture frames from your application](#) with a mobile application running on your Android target.
- [Analyze and debug your capture](#) highlights some of the analysis and debug features that are available in Arm® RenderDoc for Arm GPUs.

Additional learning resources

Additional tutorials and help articles are available as part of the RenderDoc documentation, including:

- [How do I use RenderDoc on Android?](#)
- [RenderDoc Quick Start](#)
- [How-to topics in the RenderDoc documentation](#)

2.1 Setup your Android target

Complete the required setup tasks before you use an Android target with Arm® RenderDoc for Arm GPUs.

Before you begin

Before you can setup your Android target, you must complete the following tasks:

- Install [Android Debug Bridge](#). `adb` is available with the Android SDK platform tools, which are installed as part of [Android Studio](#). Alternatively, you can download them separately as part of the [Android SDK platform tools](#).
- [Download Arm Performance Studio for free](#) and follow the installation instructions in the [Arm® Performance Studio Release Notes](#).



Your Android target must be running Android 11.0 or later.

Procedure

1. Connect your target to your computer through USB and ensure that the target is switched on.
2. Enable [Developer Mode](#) on your target.
3. On your target, go to **Settings > Developer Options** and enable **USB Debugging**. If your target asks you to authorize connection to your computer, confirm the connection. Test the connection by entering `adb devices` in a command-line utility. If successful, the command returns the target ID.

```
adb devices
List of devices attached
ce12345abcdef1a1234    device
```

If you see that the target is listed as unauthorized, try disabling and re-enabling **USB Debugging** on the target, and accept the authorization prompt to enable connection to the computer.

4. If you have Android Studio open, it interferes with RenderDoc debugging by attaching to the package itself. You can either close Android Studio, or disable adb integration in Android Studio using the **Tools > Android > Enable ADB integration** setting.

Next steps

After connecting and configuring your Android target, you can now perform an on-target capture using Arm® RenderDoc for Arm GPUs.

- [Capture frames from your application](#)

2.2 Setup your Linux target

Complete the required setup tasks before you use a Linux target with Arm® RenderDoc for Arm GPUs.

Before you begin

Before you can setup your Linux target, you must complete the following tasks:

- [Download Arm Performance Studio for free](#) and follow the installation instructions in the [Arm® Performance Studio Release Notes](#).
- Ensure that your host is running the minimum required version of Linux, or later:
 - `glibc`: Ubuntu 22.04
 - `musl`: Alpine 3.20.1

Procedure

1. Connect your target to your computer and ensure that the target is switched on.
2. Send the `glibc` and `musl` library files to the server using SCP. You can use any of the following commands to copy the files:

- `glibc`

```
scp share/renderdoc/plugins/aarch64/glibc/bin/renderdoccmd <remote device>:<remote path>
scp share/renderdoc/plugins/aarch64/glibc/lib/librenderdoc.so <remote device>:<remote path>
```

- `musl`



```
scp share/renderdoc/plugins/aarch64/musl/bin/renderdoccmd <remote device>:<remote path>
scp share/renderdoc/plugins/aarch64/musl/lib/librenderdoc.so <remote device>:<remote path>
```

3. Setup the Vulkan layer files to the correct location on the server:

```
renderdoccmd vulkanlayer --register --<system or user>
```

4. Run the remote server.
5. Connect to the remote server in the RenderDoc **Remote Host Manager** dialog box:
 - a. Go to **Tools > Manage Remote Servers**.
 - b. In **Hostname**, enter the address of the remote server.
 - c. Click **Add**.

The server is then shown in the **Hostname** list. The icon next to your server shows the connection status of your server:

-  Connected
-  Not connected. Make sure that the server is accessible.

If required, to refresh the list of servers, click **Refresh All**.

6. Close the **Remote Host Manager** dialog box.
For more information, see the RenderDoc documentation at [How do I capture and replay over a network?](#)

Next steps

After connecting and configuring your Linux target, you can now perform an on-target capture using Arm® RenderDoc for Arm GPUs.

- [Capture frames from your application](#)

2.3 Capture frames from your application

Set up and perform a capture on your target, ready for analysis using Arm® RenderDoc for Arm GPUs.

Before you begin

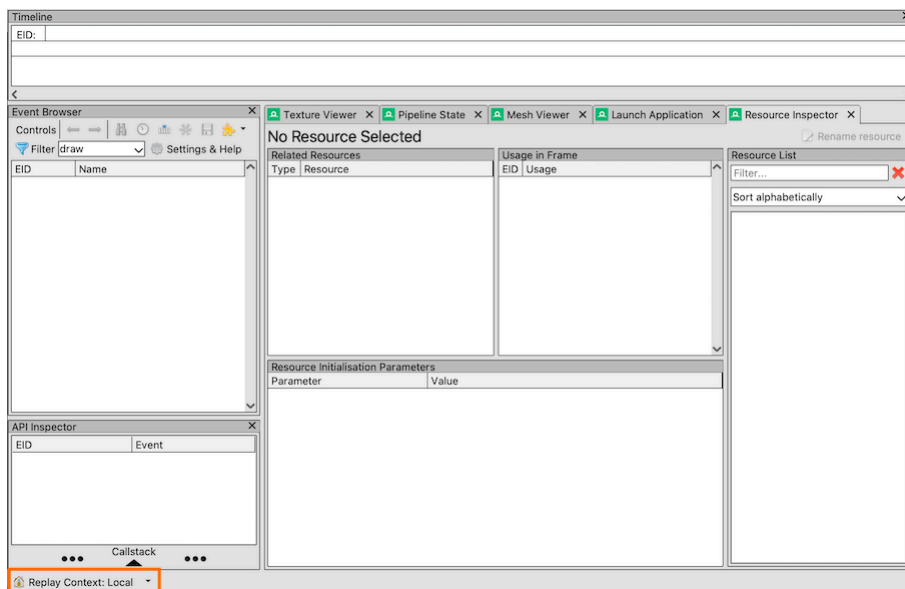
Before you begin this task, you must:

- Set up your target and system as described in [Setup your Android target](#) or [Setup your Linux target](#).
- Ensure that your application is installed on your target.

Procedure

1. Connect your target to your host machine:
 - For Android only, ensure that adb can detect the target.
 - For Linux only, ensure that you can establish a TCP/IP connection to the target.
2. Select your connected target from the **Replay Context** dropdown list at the bottom left of the RenderDoc UI.

Figure 2-1: Replay Context dropdown location in RenderDoc



If you do not see your target listed in the dropdown list, check that you have set up the target correctly. See either [Setup your Android target](#) or [Setup your Linux target](#).



Note

A red cross next to your target indicates that the target is disconnected.

For Android only, when you connect for the first time, RenderDoc installs its capture and replay application on the target. Now the target is shown as connected in the dropdown list. After connecting, the RenderDoc APK starts running on your target.

3. In RenderDoc, navigate to the **Launch Application** tab, and set the following options:
 - a. Set the **Executable Path** to the application that you want to debug. Click the **Browse** button to view all of the installed application packages on the target and find the `.exe` file:




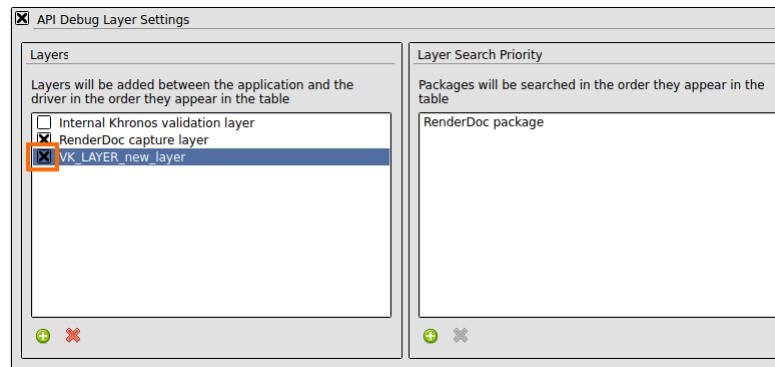
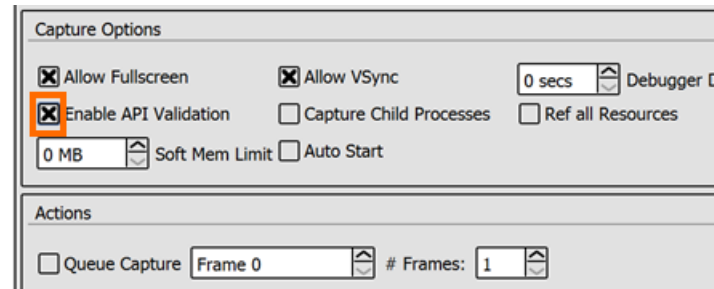
- For Android only, choose the required application package folder and select the activity executable within it.
 - For Linux only, select the executable file.
- Optionally, you can specify the **Working Directory**. If you do not specify this, the capture is temporarily saved in the same location as the executable.
 - In the **Actions** section, you can also specify additional **Capture Options** and specify a list of frames to capture.
 - Arm® RenderDoc for Arm GPUs reads any Vulkan debug layers on the device and displays them in the **API Debug Layer Settings** section. Setup your Vulkan debug layers:
 - Add or remove layers and packages for your capture session:
 - To add a new layer, click the **Add new layer** button  located under the **Layers** table, then enter the layer name in the new row added to the table.
 - To add a new package, click the **Add new package** button  located under the **Layer Search Priority** table, then select a package from the popup list.
 - To remove a layer or package, select the item that you want to remove, then click either the **Remove selected layer** button or **Remove selected package** button  located under the appropriate table.
 - To enable layers for your capture session, select the **Enabled** checkbox. Clear the **Enabled** checkbox for any layers that you do not want to use.

Figure 2-2: Enable layers

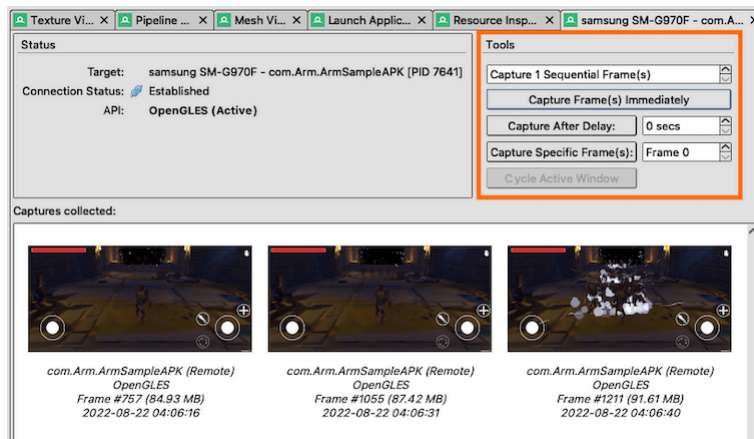
- The layers and packages are processed in the same order as they appear in the tables. Click and drag the layers and packages until they are in the required order.

**Note**

- You cannot edit or remove the included RenderDoc layer and RenderDoc package because they are required for the capture.
- To enable the validation layer, in the **Capture Options** dialog, select the **Enable API Validation** checkbox. Clear the **Enable API Validation** checkbox to disable this layer if you do not require it for your capture session.

Figure 2-3: Enable API Validation

- Your capture will be unsuccessful if you add any new layers that do not exist.
 - Layer settings persist between any captures that you open in the same capture session. When a device disconnects, or when RenderDoc closes, the layer settings on the device revert back to the same state they were in before the device connected to RenderDoc.
4. Click **Launch**, to start the application running on your target. After a successful launch, a new target-specific tab opens in the UI where you can select the frames that you want to capture:
 - Capture one or more frames immediately
 - Capture one or more frames after a delay
 - Capture one or more frames after a specific frame

Figure 2-4: Capture frame controls

Captured frames are stored temporarily on the target.

5. When you have finished capturing the frames of interest, stop the application that you are debugging. Keep RenderDoc running though, so that you can analyze and debug your captures:

- For Android only, keep the RenderDoc APK running.
 - For Linux only, keep the `renderdoccmd` running.
6. To open a capture, double-click on the thumbnail of the captured frame.

Next steps

When you have finished capturing, you can then analyze, debug, and edit your frames using RenderDoc.

- [Analyze and debug your capture](#)

2.4 Analyze and debug your capture

Use the debug features available in Arm® RenderDoc for Arm GPUs to analyze and debug your capture.

The primary purpose of RenderDoc is to help you diagnose rendering problems that occur in your application. When you have captured a frame, you can use the tool to interactively explore all of its API calls and rendering events. By stepping through the frame you can identify problem rendering events, and then review the configuration used by the event to discover the cause.





Note

This section describes some tasks that you can do with Arm® RenderDoc for Arm GPUs after you have captured a frame. See the [RenderDoc documentation](#) to explore the full list of features.

Load a saved capture

You can either load a frame capture for analysis directly after capture, or you can load a previously saved frame capture.

1. Ensure that your Android target is connected to your computer, and select your target from the **Replay Context** dropdown list.
2. If you have just taken a new frame capture, select the capture from the **Captures collected** window and click **Open**.
3. Alternatively, you can open a previous capture:
 - To load a previously saved frame capture, click **File > Open Capture**.
 - Setup Vulkan debug layers for your capture from the **File > Open Capture with Options** menu. The **API Debug Layer Settings** section shows the Vulkan layers and packages that Arm® RenderDoc for Arm GPUs reads from your device:
 - For Android users only, you can add or remove layers and packages for your capture:
 - To add a new layer, click the **Add new layer** button  located under the **Layers** table, then enter the layer name in the new row added to the table.
 - To add a new package, click the **Add new package** button  located under the **Layer Search Priority** table, then select a package from the popup list.


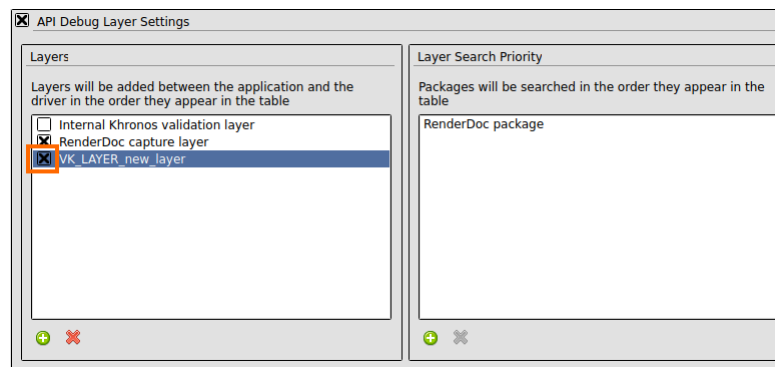
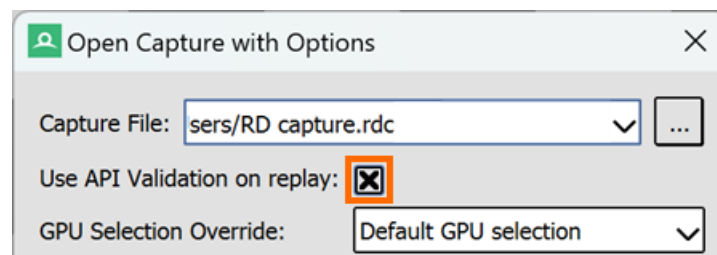
- To remove a layer or package, select the item that you want to remove, then click either the **Remove selected layer** button or **Remove selected package** button  located under the appropriate table.
- To enable layers for your capture session, select the **Enabled** checkbox. Clear the **Enabled** checkbox for any layers that you do not want to use.

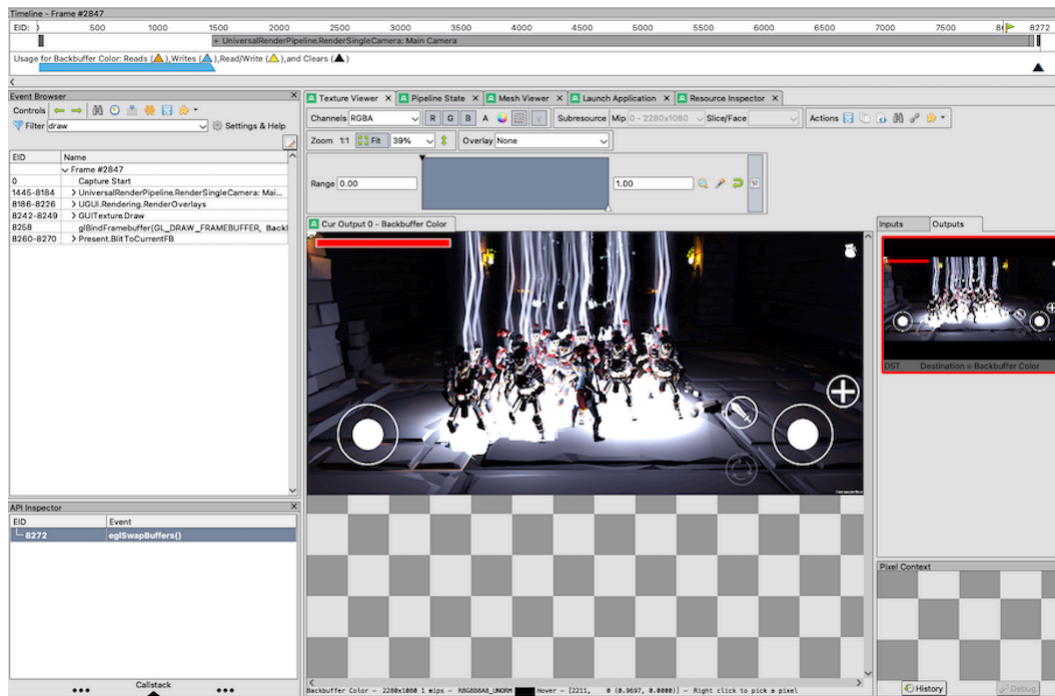
Figure 2-5: Enable layers

- The layers and packages are processed in the same order as they appear in the tables. Click and drag the layers and packages until they are in the required order.
-
- To enable the validation layer, in the **Open Capture with Options** dialog, select the **Use API Validation on replay** checkbox. Clear the **Use API Validation on replay** checkbox to disable this layer if you do not require it.

Figure 2-6: Enable API Validation

- Your capture will be unsuccessful if you add any new layers that do not exist.
 - Layer settings persist between any captures that you open in the same replay session. When a device disconnects, or when RenderDoc closes, the layer settings on the device revert back to the same state they were in before the device connected to RenderDoc.
-

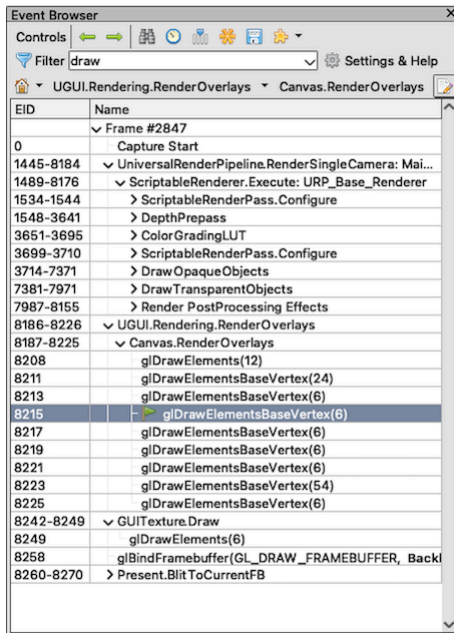
When the frame has loaded, it is displayed on the target and in the **Texture Viewer** tab, and the **Event Browser** is populated in Arm® RenderDoc for Arm GPUs.

Figure 2-7: RenderDoc UI with a loaded frame

Navigate the frame capture

Use the **Event Browser** to navigate through the frame capture. By default, the **Event Browser** shows all `action()` events, which include draws, copies, and clears. Enter a search term in the **Filter** dropdown to filter these events.

Filter expressions can be complex. For more details, see the RenderDoc documentation at [How do I filter visible events?](#).

Figure 2-8: Event browser view in RenderDoc

Selected events are highlighted with a green flag. All the other windows in the UI update to display information that is specific to the selected event. You can use this to view the render state and data resources that are used by the current event, and view the GPU output that resulted from it.

For more details, see the RenderDoc documentation at [Event Browser](#)

Debug a shader

Use the **Mesh Viewer** in RenderDoc to select an input vertex. Right-click anywhere in a row that is of interest, and select **Debug this Vertex** to open the vertex shader in the shader debugger.



Note

If the **Debug this Vertex** button is grayed out, this option might not be available for your target and API combination.

For more details, see the RenderDoc documentation at:

- [How do I debug a shader?](#)
- [How do I use shader debug information?](#)

Edit a shader

Shaders are one of the most important aspects of GPU processing, and errors in user shaders are a common cause of rendering problems. RenderDoc allows you to edit a shader used by an action event and replay it on the connected target. This feature allows you to quickly iterate changes without having to rebuild and deploy your entire application.

To launch the shader editor, click the **Pipeline State** tab then click the **Edit** button next to the shader. A text editor opens where you can make your edits to the code. To save and recompile the code, click **Apply changes**.

Figure 2-9: Edit shader button

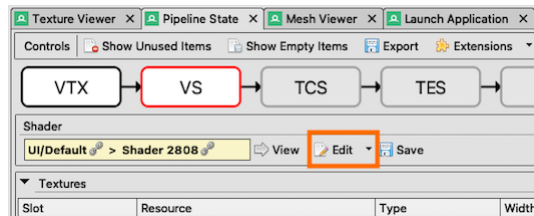
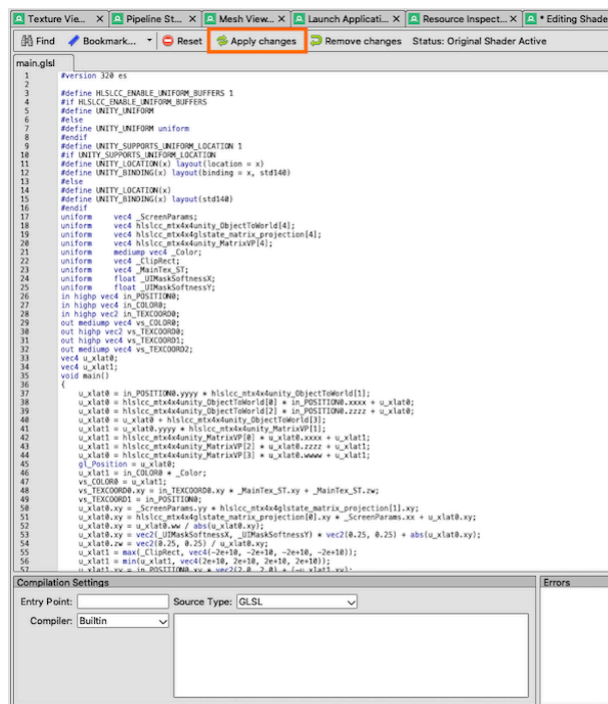


Figure 2-10: Editing the shader code



Any changes to the shader will affect all action events that use this shader.

For more details, see the RenderDoc documentation at [How do I edit a shader?](#)

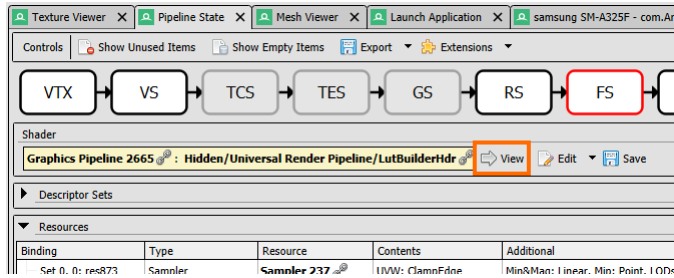
Review shader performance with Mali™ Offline Compiler

To review performance of your Vulkan shaders on the target GPU, use `ma1ioc` to statically analyze the SPIR-V disassembly and generate a performance report from Mali™ Offline Compiler.

The report enables you to see details about the configuration, how the shader uses resources, performance cycle costs of the shader, and properties of the shader that can impact performance.

1. In the **Event Browser**, select a draw command.
2. Click the **Pipeline State** tab, select a shader, then click the **View** button.

Figure 2-11: View shader source



3. In the **Disassembly type** dropdown menu, and select the Mali Shader Performance report:
 - **Mali Shader Performance (maliloc (Text Report))** opens a formatted and human readable text output of your shaders.
 - **Mali Shader Performance (maliloc (JSON Report))** opens a machine-readable JSON format that you can export to other tools.

Figure 2-12: Disassembly_type_menu

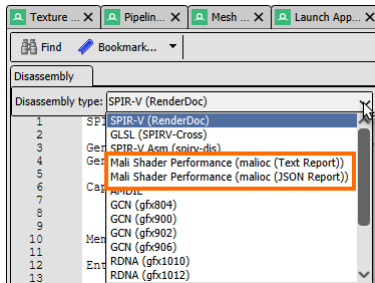


Figure 2-13: Example Mali Offline Compiler performance report

```

Disassembly type: Mali Shader Performance (mallic (Text Report))
1  Mali Offline Compiler v8.5.0 (Build 97a489)
2  Copyright (c) 2007-2024 Arm Limited. All rights reserved.
3
4  Configuration
5  =====
6
7  Hardware: Mali-G715 r0p0
8  Architecture: Valhall
9  Driver: r5lp0-00rel0
10 Shader type: Vulkan Fragment
11
12 Main shader
13 =====
14
15 Work registers: 11 (34% used at 100% occupancy)
16 Uniform registers: 4 (3% used)
17 Stack spilling: false
18 16-bit arithmetic: 33%
19
20
21
22
23
24
25
26
27
28 Shader properties
29 =====
30
31 Has uniform computation: false
32 Has side-effects: false
33 Modifies coverage: false
34 Uses late ZS test: false
35 Uses late ZS update: false
36 Reads color buffer: false
37
38 Note: This tool shows only the shader-visible property state.
39 API configuration may also impact the value of some properties.
40
41

```

| | A | FMA | CVT | SFU | LS | V | T | Bound |
|---------------------------|------|------|------|------|------|------|------|-------|
| Total instruction cycles: | 0.05 | 0.05 | 0.00 | 0.00 | 0.00 | 0.12 | 0.12 | V, T |
| Shortest path cycles: | 0.05 | 0.05 | 0.00 | 0.00 | 0.00 | 0.12 | 0.12 | V, T |
| Longest path cycles: | 0.05 | 0.05 | 0.00 | 0.00 | 0.00 | 0.12 | 0.12 | V, T |

A = Arithmetic, FMA = Arith FMA, CVT = Arith CVT, SFU = Arith SFU,
LS = Load/Store, V = Varying, T = Texture

See the [Arm® Mali™ Offline Compiler User Guide](#) for more information about the metrics detailed in the Mali™ Offline Compiler performance report.

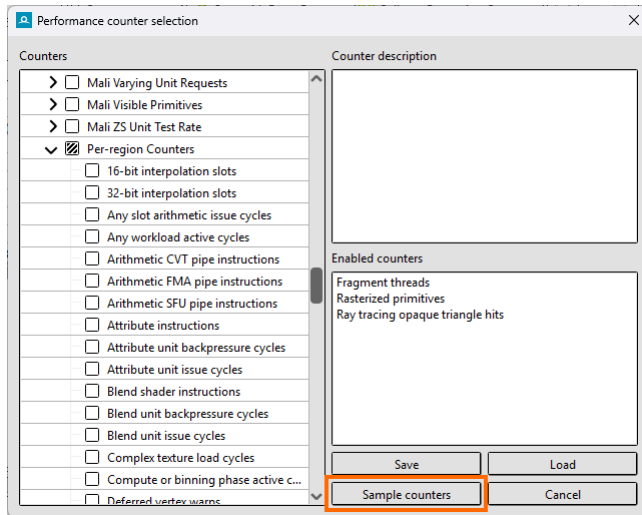
Review per-region counter performance

For captures on Android devices containing Mali™-G1 or later, you can view a heatmap that shows regions of high processing activity. Compare the heatmap to the rendered image to identify objects that might cause performance issues, and require optimization.

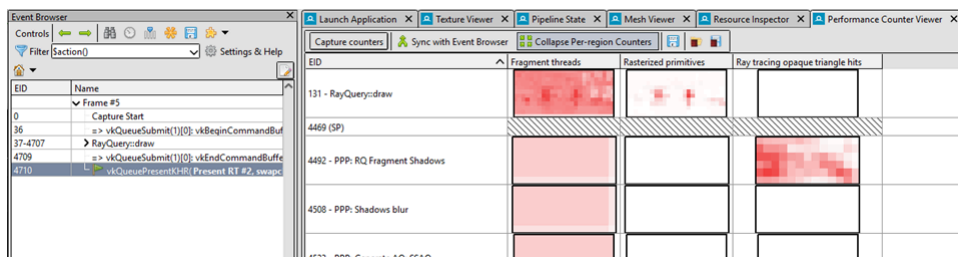
1. To select the per-region performance counters, open the **Performance Counter Viewer** tab, and click the **Capture counters** button.

The **Performance counter selection** dialog opens and shows all of the performance counters that are supported by your connected device.

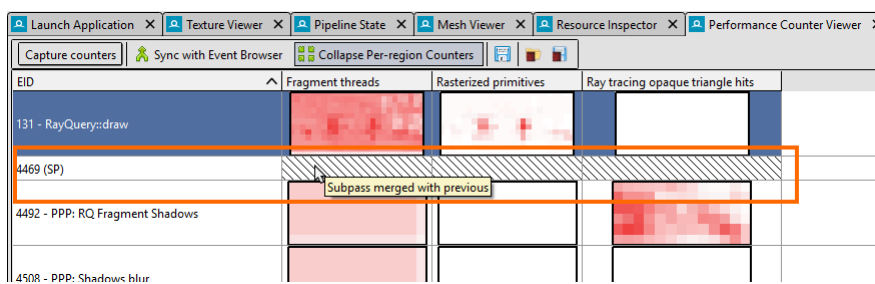
2. To collect the performance counter data, expand the **ARM > Per-region Counters** list, and select up to 4 per-region counters. Click the **Sample counters** button.

Figure 2-14: Per-region Counters selected

The heatmap uses the worst and best values for each selected counter type as the heatmap bounds. The heatmap displays as the background color that becomes a brighter red in regions where processing activity is higher. The proportions of the heatmap boxes correspond to the aspect ratio of the render pass or subpass, which can change during the frame.

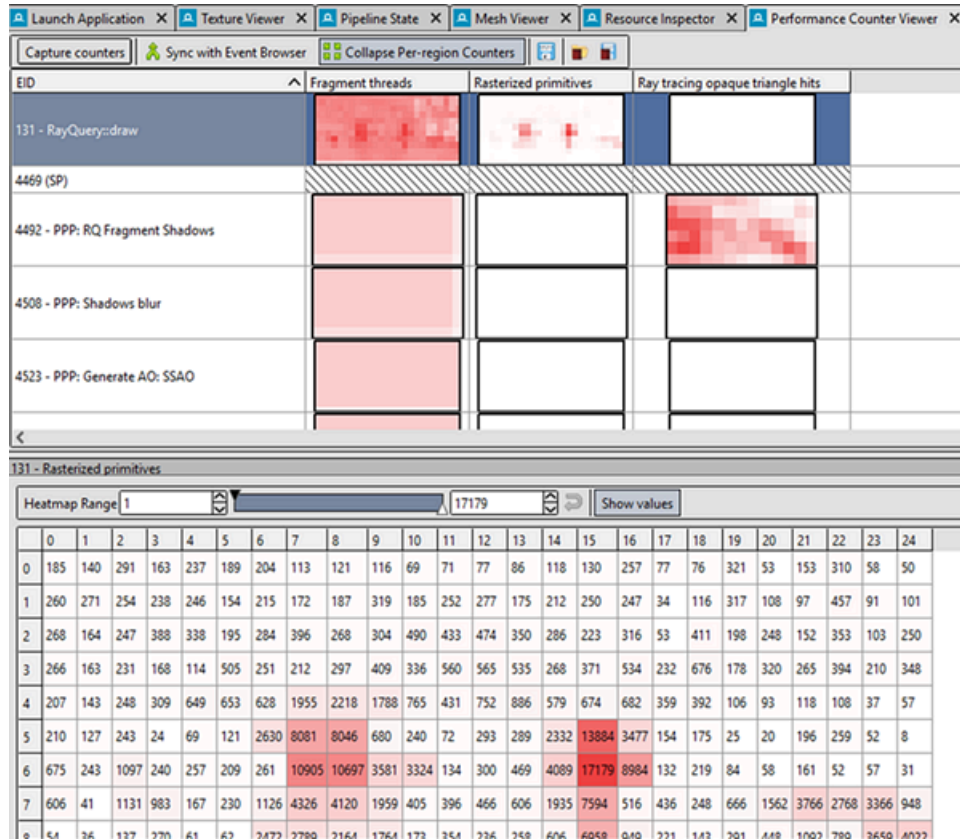
Figure 2-15: Per-region heatmaps

Subpasses are shown with the suffix **SP** in the **EID**. Diagonal hatch lines replace the heatmap to show any subpasses that were merged by the driver to optimize performance. To see which passes were merged by the driver, hover the mouse pointer over a flattened subpass. If the driver cannot merge a subpass, the heatmap is shown, and the tooltip explains the reason.

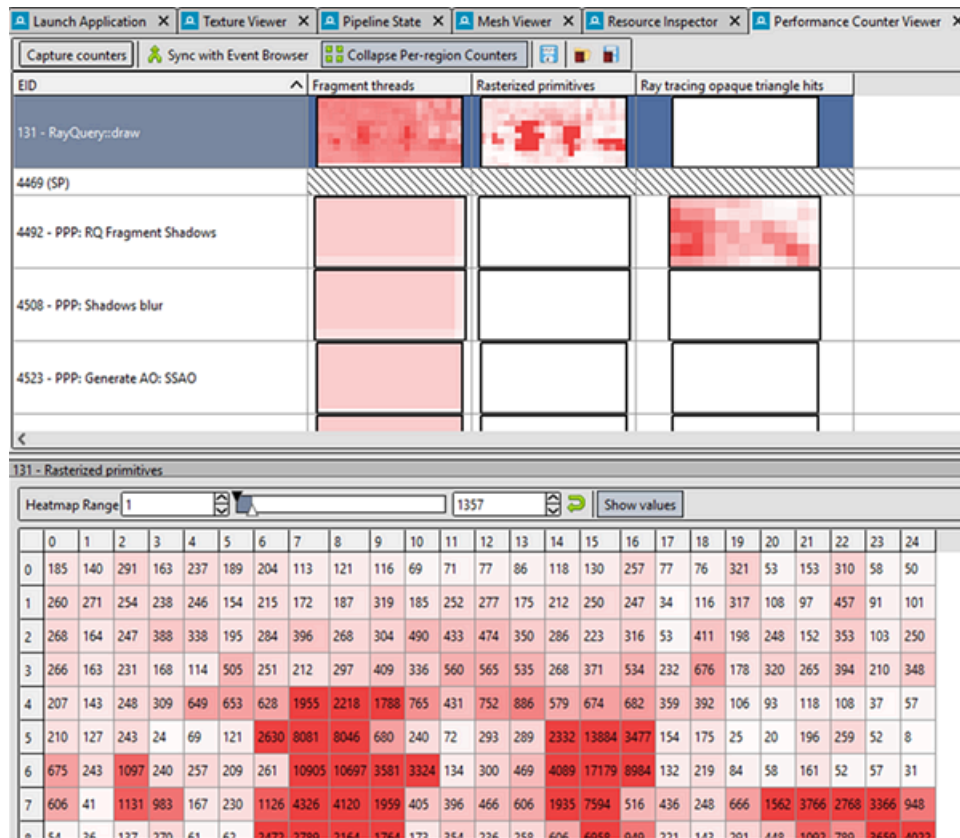
Figure 2-16: Merged subpass

- To show a grid of the raw counter values together with the heatmap color background, double-click on a heatmap box.

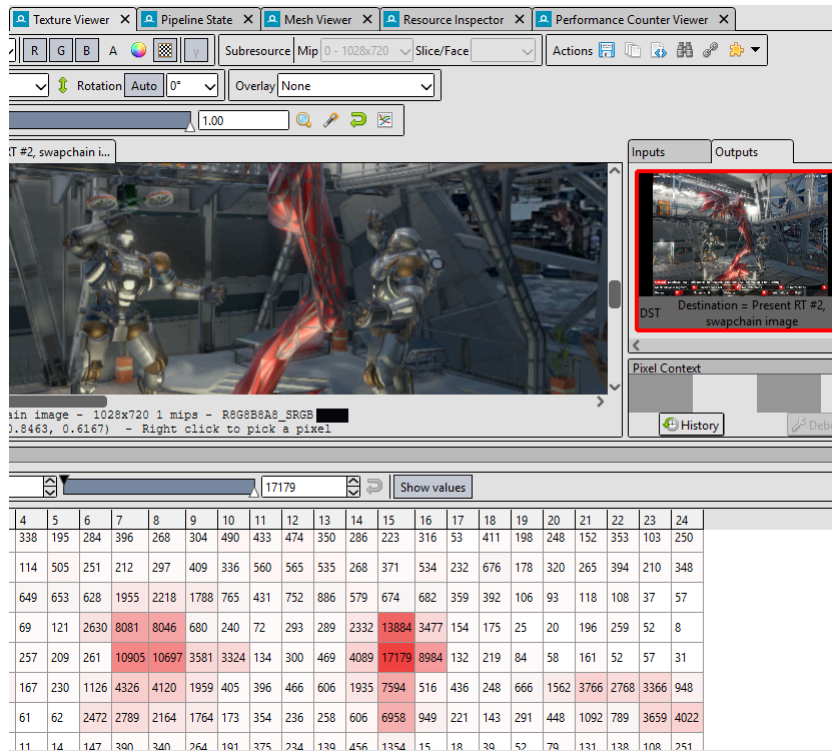
Figure 2-17: Per-region heatmap values



You can flatten the range of values to enhance the heatmap color for a particular range. Change the minimum and maximum values to show the range that you are interested in.

Figure 2-18: Per-region enhanced heatmap range

- To see what was being rendered to cause the performance issue, you can look for the corresponding **EID** for the API call in the **Event Browser**. Or, to identify complex objects that require optimizing, open the **Texture Viewer** and compare the bright red regions on the heatmap with objects in the rendered image.

Figure 2-19: Compare heatmap to the rendered image

- Optionally, you can export the heatmap range for post-process analysis of each counter type. Exporting the heatmap range for each counter type before and after you make changes to your application enables you to compare the captures, and determine whether the result is as intended.

3. Capture and analyze ML graph pipeline data

Arm® RenderDoc for Arm GPUs supports the capture and analysis of neural graphics on Vulkan using the Arm Neural Graphic Development Kit. Use Arm RenderDoc for Arm GPUs to capture frames from your Vulkan application using the Arm ML extensions for Vulkan. Then, use the debug features to inspect your data graph pipeline, and explore the tensor resources.

Before you begin

Before you can capture a frame that uses the ML extensions for Vulkan, you must:

- Install and enable the [ML extensions for Vulkan](#). The extensions provide ML support for the tensor resources and data graph pipeline. For more information, see the [ML SDK for Vulkan documentation](#).
- Optionally, to explore the data graph pipeline, you can install the [Tensor and Data Graph samples](#). The emulation layers are configured using the Vulkan Configurator tool, which is part of the [Vulkan SDK](#).
- For Unreal Engine users:
 - Install the Unreal Engine plugin provided in the [Neural Graphics Development Kit](#).
 - In your Unreal Engine project, go to **Edit > Project Settings > Plugins > RenderDoc > RenderDoc executable path** and enter the path to the `qrenderdoc.exe` binary. Restart Unreal Engine.
- In RenderDoc, register the RenderDoc Vulkan capture layer. Click on the warning in the **Launch Application** dialog as described in [Vulkan Support](#).



Note

Arm RenderDoc for Arm GPUs provides support only for Windows operating systems that are running the ML Emulation Layers for Vulkan from the Arm [Neural Graphics Development Kit](#).

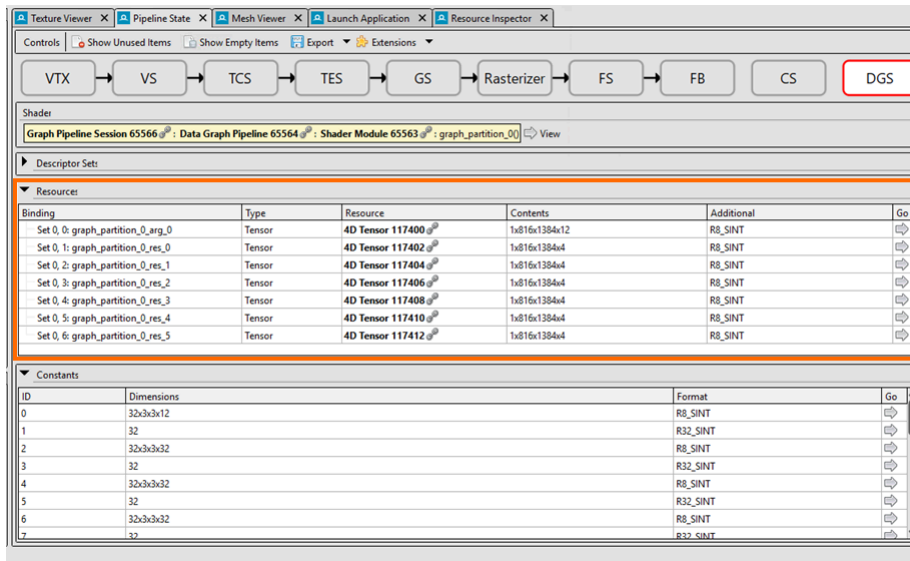
Capture the data graph pipeline

To capture structured tensor data from the data graph pipeline, use the ML extensions for Vulkan with your Vulkan application:

- For Windows users:
 1. In RenderDoc, navigate to the **Launch Application** tab.
 2. Set the required options in the **Program**, **Capture Options**, and **Actions** dialogs.
 3. Click **Launch**.

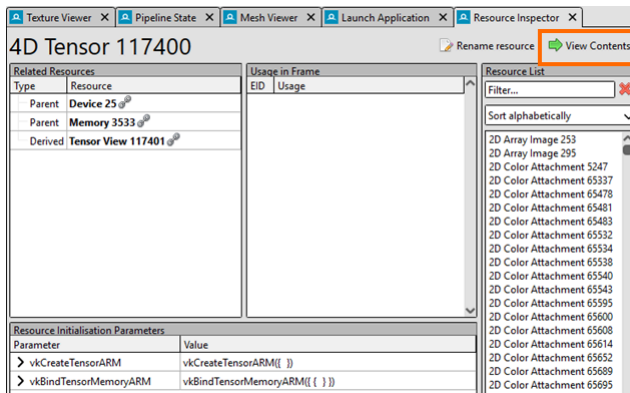
For more information, see [How do I capture a frame](#) in the RenderDoc documentation.

- For Unreal Engine users, you can capture frames either by:
 - Attaching Unreal Engine to the running instance directly in RenderDoc.

Figure 3-2: Tensor resources

Click on a tensor resource for information about the resource parameters, usage, and attachments.

- To open a resource, click **View Contents**.

Figure 3-3: View tensor resource

The co-ordinates and their pixel values are displayed in a multi-dimensional matrix. You can use the display options to manipulate the data view. For example to view a 2D slice of the tensor.

Figure 3-4: Example tensor data array

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|----|------|------|------|-----|------|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0 | -115 | -79 | -103 | -85 | -84 | -86 | -88 | -93 | -94 | -92 | -93 | -94 | -95 | -95 | -93 | -92 | -92 | -94 | -95 | -96 | -94 |
| 1 | -121 | -105 | -115 | -99 | -93 | -97 | -101 | -105 | -107 | -104 | -104 | -104 | -104 | -103 | -103 | -103 | -103 | -105 | -105 | -105 | -105 |
| 2 | -116 | -87 | -74 | -78 | -90 | -85 | -89 | -94 | -96 | -95 | -94 | -96 | -95 | -94 | -95 | -96 | -97 | -97 | -98 | -99 | -99 |
| 3 | -111 | -74 | -66 | -84 | -103 | -94 | -90 | -91 | -92 | -91 | -91 | -93 | -91 | -88 | -87 | -88 | -91 | -91 | -92 | -93 | -92 |
| 4 | -115 | -84 | -87 | -97 | -98 | -90 | -89 | -91 | -91 | -90 | -90 | -90 | -88 | -86 | -86 | -84 | -84 | -85 | -84 | -83 | -83 |
| 5 | -110 | -79 | -87 | -94 | -86 | -77 | -84 | -85 | -89 | -89 | -87 | -86 | -85 | -85 | -84 | -82 | -82 | -84 | -82 | -81 | -81 |
| 6 | -113 | -81 | -89 | -92 | -90 | -86 | -91 | -84 | -85 | -90 | -87 | -84 | -83 | -83 | -83 | -82 | -81 | -83 | -83 | -83 | -82 |
| 7 | -112 | -82 | -86 | -87 | -89 | -87 | -89 | -79 | -81 | -87 | -84 | -83 | -79 | -79 | -81 | -79 | -76 | -78 | -79 | -78 | -77 |
| 8 | -110 | -79 | -86 | -87 | -86 | -86 | -89 | -77 | -78 | -87 | -85 | -84 | -83 | -79 | -82 | -82 | -79 | -78 | -79 | -79 | -78 |
| 9 | -111 | -81 | -88 | -91 | -85 | -85 | -87 | -74 | -74 | -84 | -82 | -82 | -81 | -77 | -78 | -78 | -77 | -79 | -79 | -78 | -78 |
| 10 | -111 | -81 | -87 | -89 | -83 | -84 | -88 | -76 | -74 | -82 | -78 | -78 | -78 | -76 | -77 | -76 | -74 | -77 | -79 | -79 | -79 |
| 11 | -110 | -79 | -85 | -87 | -83 | -85 | -87 | -74 | -76 | -84 | -78 | -77 | -78 | -77 | -77 | -76 | -74 | -77 | -79 | -79 | -79 |
| 12 | -110 | -78 | -84 | -87 | -83 | -87 | -89 | -70 | -69 | -82 | -78 | -76 | -77 | -76 | -74 | -73 | -73 | -74 | -77 | -77 | -77 |
| 13 | -110 | -78 | -85 | -89 | -83 | -88 | -91 | -73 | -68 | -82 | -79 | -77 | -78 | -78 | -77 | -76 | -74 | -74 | -77 | -78 | -77 |
| 14 | -110 | -79 | -88 | -90 | -83 | -87 | -90 | -77 | -72 | -83 | -78 | -74 | -76 | -76 | -76 | -76 | -74 | -72 | -74 | -74 | -73 |

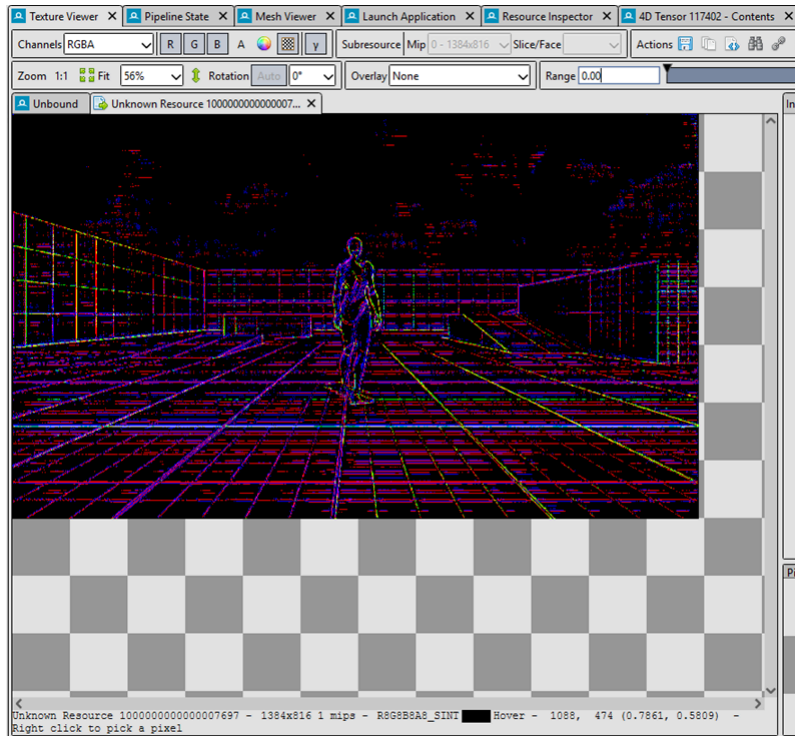
Look for unexpected patterns in the data, anomalies where values jump very high or low, or are zero. Repeated patterns, repeated values, unused values, or low values over large areas all indicate where you can improve performance.

Alternatively, to see a visual representation of the tensor data, select the **Image Preview** checkbox, then click the **Render in texture viewer** icon.

Figure 3-5: Render in texture viewer icon

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|----|------|------|------|-----|------|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0 | -115 | -79 | -103 | -85 | -84 | -86 | -88 | -93 | -94 | -92 | -93 | -94 | -95 | -95 | -93 | -92 | -92 | -94 | -95 | -96 | -94 |
| 1 | -121 | -105 | -115 | -99 | -93 | -97 | -101 | -105 | -107 | -104 | -104 | -104 | -104 | -103 | -103 | -103 | -103 | -105 | -105 | -105 | -105 |
| 2 | -116 | -87 | -74 | -78 | -90 | -85 | -89 | -94 | -96 | -95 | -94 | -96 | -95 | -94 | -95 | -96 | -97 | -97 | -98 | -99 | -99 |
| 3 | -111 | -74 | -66 | -84 | -103 | -94 | -90 | -91 | -92 | -91 | -91 | -93 | -91 | -88 | -87 | -88 | -91 | -91 | -92 | -93 | -92 |
| 4 | -115 | -84 | -87 | -97 | -98 | -90 | -89 | -91 | -91 | -90 | -90 | -90 | -88 | -86 | -86 | -84 | -84 | -85 | -84 | -83 | -83 |
| 5 | -110 | -79 | -87 | -94 | -86 | -77 | -84 | -85 | -89 | -89 | -87 | -86 | -85 | -85 | -84 | -82 | -82 | -84 | -82 | -81 | -81 |
| 6 | -113 | -81 | -89 | -92 | -90 | -86 | -91 | -84 | -85 | -90 | -87 | -84 | -83 | -83 | -83 | -82 | -81 | -83 | -83 | -83 | -82 |
| 7 | -112 | -82 | -86 | -87 | -89 | -87 | -89 | -79 | -81 | -87 | -84 | -83 | -79 | -79 | -81 | -79 | -76 | -78 | -79 | -78 | -77 |
| 8 | -110 | -79 | -86 | -87 | -86 | -86 | -89 | -77 | -78 | -87 | -85 | -84 | -83 | -79 | -82 | -82 | -79 | -78 | -79 | -79 | -78 |
| 9 | -111 | -81 | -88 | -91 | -85 | -85 | -87 | -74 | -74 | -84 | -82 | -82 | -81 | -77 | -78 | -78 | -77 | -79 | -79 | -78 | -78 |
| 10 | -111 | -81 | -87 | -89 | -83 | -84 | -88 | -76 | -74 | -82 | -78 | -78 | -78 | -76 | -77 | -76 | -74 | -77 | -79 | -79 | -79 |
| 11 | -110 | -79 | -85 | -87 | -83 | -85 | -87 | -74 | -76 | -84 | -78 | -77 | -78 | -77 | -77 | -76 | -74 | -77 | -79 | -79 | -79 |
| 12 | -110 | -78 | -84 | -87 | -83 | -87 | -89 | -70 | -69 | -82 | -78 | -76 | -77 | -76 | -74 | -73 | -73 | -74 | -77 | -77 | -77 |
| 13 | -110 | -78 | -85 | -89 | -83 | -88 | -91 | -73 | -68 | -82 | -79 | -77 | -78 | -78 | -77 | -76 | -74 | -74 | -77 | -78 | -77 |
| 14 | -110 | -79 | -88 | -90 | -83 | -87 | -90 | -77 | -72 | -83 | -78 | -74 | -76 | -76 | -76 | -76 | -74 | -72 | -74 | -74 | -73 |

Figure 3-6: Image representation of tensor data



Viewing the data as an image enables you to identify problems in the data values, such as:

- Missing patterns or features
 - Unexpected artifacts
 - Brightness or saturation of colors
 - Unexpected aspect ratios
5. To pan around the image, click and hold the left mouse button. To see the color format and values of an individual pixel, right-click on a pixel. The color values are displayed in a panel underneath the image viewer.

When you have finished exploring the tensor data, update your application code to resolve any problems that you found.

4. Troubleshooting RenderDoc

Find answers to problems that might occur when capturing or analyzing data in RenderDoc.

4.1 Capture fails to transfer over to the Android target

When you are connected to an Android target over USB, and you are loading a capture from a Linux or Mac host, the transfer of the capture to the target can fail on later versions of adb. You might also find that adb gets into a state where it cannot reconnect, and you must force it to stop.

A version of adb v34 or later disconnects the USB device mid-transfer

From adb version 34 or later, the default USB backend is `libusb`. You can check which USB backend that adb is using with the following command:

```
$ adb server-status
```

The following example shows an output returned for `libusb`:

```
usb_backend: LIBUSB
mdns_backend: OPENSOURCE
version: "35.0.2"
build: "12147458"
executable_absolute_path: "/tools/android-sdk/platform-tools/adb"
log_absolute_path: "/tmp/adb.28550.log"
os: "Linux 6.8.0-48-generic (x86_64)"
```

Solution

Start adb with the native USB backend enabled:

```
$ ADB_LIBUSB=0 adb start-server
```

The following example shows an output returned for the native USB backend:

```
usb_backend: NATIVE
usb_backend_forced: true
mdns_backend: OPENSOURCE
version: "35.0.2"
build: "12147458"
executable_absolute_path: "/tools/android-sdk/platform-tools/adb"
log_absolute_path: "/tmp/adb.28550.log"
os: "Linux 6.8.0-48-generic (x86_64)"
```

5. Analytics data collection

Arm periodically collects anonymous information to understand how you use our tools and their features. We use this information to improve your experience with our tools. We do not collect any personally identifiable information.

Analytics event data

This section describes the types of analytics event data that we collect.

Host system information

We collect the following host system information to track product usage and manage our support policy:

host_os_name

The name of the host OS.

host_os_version

The version of the host OS.

host_os_cpu

The CPU architecture of the host. For example, x86-64, or arm64.

Target information

We collect the following information to track product usage and manage our support policy:

target_os_name

The architecture of the target. For example, Windows, Linux, or Android.

target_os_version

The version of the target.

Tool version information

We collect the following information from the tool:

tool_name

The name of the tool.

tool_version

The version of the tool.

Tool usage information

We collect the following tool usage information to track product usage:

user_id

An opaque ID generated by hashing your user name and host machine name.

session_id

An opaque ID generated by hashing your `user_id`, and the current date and time. This information also helps us to understand how you use features together.

Tool feature usage information

We collect the following information about the tool features:

capture_time_*

Reports how long the tool takes to complete different stages of data capture and analysis. We use this information to prioritize performance improvements in the tool roadmap.

Disabling analytics

You can disable analytics by using any of the following methods:

- Set the `ARM_DISABLE_ANALYTICS` environment variable to any value, including an empty string.
- Pass the `--disable-analytics` command-line option to any tools that emit analytics.
- In the RenderDoc menu, click **Tools -> Settings -> General**. In the **Arm Analytics** section, clear the checkbox.

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Product and document information

Read the information in these sections to understand the release status of the product and documentation, and the conventions used in Arm documents.

Product status

All products and services provided by Arm require deliverables to be prepared and made available at different levels of completeness. The information in this document indicates the appropriate level of completeness for the associated deliverables.

Product completeness status

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

Revision history

These sections can help you understand how the document has changed over time.

Document release information

The Document history table gives the issue number and the released date for each released issue of this document.

Document history

| Issue | Date | Confidentiality | Change |
|-----------|-------------------|------------------|------------------------------|
| 2025.7-00 | 11 December 2025 | Non-Confidential | New document for v2025.7 |
| 2025.5-00 | 10 September 2025 | Non-Confidential | New document for v2025.5 |
| 2025.4-01 | 12 August 2025 | Non-Confidential | Updated document for v2025.4 |
| 2025.4-00 | 31 July 2025 | Non-Confidential | New document for v2025.4 |
| 2025.2-00 | 1 May 2025 | Non-Confidential | New document for v2025.2 |
| 2025.1-00 | 20 March 2025 | Non-Confidential | New document for v2025.1 |
| 2025.0-00 | 6 February 2025 | Non-Confidential | New document for v2025.0 |
| 2024.6-00 | 28 November 2024 | Non-Confidential | New document for v2024.6 |
| 2024.4-00 | 5 September 2024 | Non-Confidential | New document for v2024.4 |

Change history

For information about the functional changes to Arm® RenderDoc for Arm GPUs, see the [Arm® Performance Studio Release Notes](#).

Conventions

The following subsections describe conventions used in Arm documents.

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: developer.arm.com/glossary.

Typographic conventions

Arm documentation uses typographical conventions to convey specific meaning.

| Convention | Use |
|----------------------------|--|
| italic | Citations. |
| bold | Interface elements, such as menu names. Terms in descriptive lists, where appropriate. |
| monospace | Text that you can enter at the keyboard, such as commands, file and program names, and source code. |
| monospace <u>underline</u> | A permitted abbreviation for a command or option. You can enter the underlined text instead of the full command or option name. |
| <and> | Encloses replaceable terms for assembler syntax where they appear in code or code fragments. For example: <div>MRC p15, 0, <Rd>, <CRn>, <CRm>, <Opcode_2></div> |
| SMALL CAPITALS | Terms that have specific technical meanings as defined in the Arm® Glossary. For example, IMPLEMENTATION DEFINED , IMPLEMENTATION SPECIFIC , UNKNOWN , and UNPREDICTABLE . |



Caution

We recommend the following. If you do not follow these recommendations your system might not work.



Your system requires the following. If you do not follow these requirements your system will not work.



You are at risk of causing permanent damage to your system or your equipment, or harming yourself.



This information is important and needs your attention.



A useful tip that might make it easier, better or faster to perform a task.



A reminder of something important that relates to the information you are reading.

Useful resources

This document contains information that is specific to this product. See the following resources for other useful information.

Arm documents are available on developer.arm.com/documentation.

Confidential documents are only available to licensees, when logged in. Each document link in the tables below provides direct access to the online version of the document.

| Arm product resources | Document ID | Confidentiality |
|--|-------------|------------------|
| Arm® Mali™ Offline Compiler User Guide | 101863 | Non-Confidential |
| Arm® Performance Studio Release Notes | 107649 | Non-Confidential |
| Download Arm Performance Studio for free | – | Non-Confidential |
| ML SDK for Vulkan documentation | – | Non-Confidential |
| ML extensions for Vulkan | – | Non-Confidential |
| Neural Graphics Development Kit | – | Non-Confidential |
| Neural Super Sampling in Unreal Engine | – | Non-Confidential |
| Tensor and Data Graph samples | – | Non-Confidential |

| Non-Arm resources | Document ID | Organization |
|--|-------------|--------------------|
| Android Debug Bridge | – | Android Developers |
| Android SDK platform tools | – | Android Developers |
| Android Studio | – | Android Developers |
| Developer Mode | – | Android Developers |
| Event Browser | – | RenderDoc |
| How do I capture a frame | – | RenderDoc |
| How do I capture and replay over a network? | – | RenderDoc |
| How do I debug a shader? | – | RenderDoc |
| How do I edit a shader? | – | RenderDoc |
| How do I filter visible events? | – | RenderDoc |
| How do I use RenderDoc on Android? | – | RenderDoc |
| How do I use shader debug information? | – | RenderDoc |
| How-to topics in the RenderDoc documentation | – | RenderDoc |
| RenderDoc Quick Start | – | RenderDoc |
| RenderDoc documentation | – | RenderDoc |
| Vulkan SDK | – | Vulkan |
| Vulkan Support | – | RenderDoc |