Qualcomm® Snapdragon™ Profiler
User Guide

October 18, 2016
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<th>Date</th>
<th>Description</th>
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<td>June 2016</td>
<td>Initial release</td>
</tr>
<tr>
<td>B</td>
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<td>Various updates throughout.</td>
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1 Overview

Qualcomm® Snapdragon™ Profiler is system profiling software for Windows, Macintosh, and Linux computers.

Snapdragon Profiler allows developers to analyze CPU, GPU, DSP*, memory, power, thermal, and network data, so they can find and fix performance bottlenecks.

- GPU APIs: OpenGL ES 3.1, Open CL 2.1, and Vulkan 1.0**
  
  * Requires a Snapdragon 820 (or later) processor
  
  ** Requires Android N (or Android 6.0 device with a graphics driver that supports Vulkan)

1.1 Data capture modes

Snapdragon Profiler provides three data capture modes offering different views of device performance: Realtime, Trace Capture, and Snapshot Capture.

Realtime

Realtime view makes it easy to correlate system resource usage on a timeline.

- Analyze CPU, GPU, DSP*, memory, power, thermal, and network data metrics
- Select from over 150 different hardware performance counters in 22 categories
  
  * Requires a Snapdragon 820 (or later) processor

Trace Capture

Trace Capture mode allows you to visualize kernel and system events on a timeline to analyze low-level system events across the CPU, GPU, and DSP. View CPU scheduling and GPU stage data to see where your application is spending its time.

Snapshot Capture

Snapshot Capture mode allows you to capture and debug a rendered frame from any OpenGL ES application:

- Step through and replay a rendered frame draw call-by-draw call
- View and edit shaders and preview the results on your device
- View and debug pixel history
- Capture and view GPU metrics per draw call

Note: Snapdragon Capture mode currently works only on mobile devices with a Qualcomm Snapdragon 805 (or later) processor and Android 6.0 (or later)
# 2 System Requirements

Table 2-1 lists the Snapdragon Profiler system requirements.

## Table 2-1 System requirements

| Hardware | • PC running Microsoft Windows 7, 8.x, or 10  
| • Mac running OS X 10.10 (Yosemite) or later  
| • PC running Ubuntu Linux 14.04 (Trusty Tahr) or later |
| Software | • Windows PC  
| • Android Debug Bridge (ADB) 1.0.32 or later.  
| • Mac OS X  
| • Android Debug Bridge (ADB) 1.0.32 or later  
| • Latest Mono Framework at [http://www.mono-project.com/download/#download-mac](http://www.mono-project.com/download/#download-mac)  
| • Linux Ubuntu  
| • Android Debug Bridge (ADB) 1.0.32 or later  
| • Latest Mono Framework at [http://www.mono-project.com/download/#download-lin](http://www.mono-project.com/download/#download-lin)  
| • Latest libc++ C++ Runtime  
| • Java JRE 1.7.0_79 or later |
| Devices | • Any Android 5.0 (or later) device powered by a Snapdragon processor; a Nexus device is recommended; Snapdragon Capture mode requires a mobile device with a Qualcomm Snapdragon 805, (or later) processor.  
| • Different device configurations have different metrics available in Snapdragon Profiler |

**NOTE:** Snapdragon Profiler is designed to work best with devices powered by Snapdragon processors. Although some limited functionality may exist on non-Snapdragon devices, not all profiling metrics will be available.
3 Install, Launch, and Connect

3.1 Install Snapdragon Profiler

3.1.1 Microsoft Windows installation
1. Run the Snapdragon Profiler installer on the host machine. It is recommended to run the Installer with Administrator privileges.
2. The Installer displays the required steps and prompts for any dependencies it cannot find.
3. Snapdragon Profiler installs to:
   a. C:\Program Files (x86)\Qualcomm\Snapdragon Profiler

3.1.2 Mac OS X installation
1. Download and install the latest Mono Framework for Mac OS X at:
   http://www.mono-project.com/download
2. Once the Mono Framework is installed, click the Snapdragon Profiler .dmg image in the Finder to mount it.
3. Drag and drop the SnapdragonProfiler.app to the Applications folder.

3.1.3 Ubuntu Linux installation
1. Download and install the latest Mono Framework for Ubuntu Linux at:
   http://www.mono-project.com/download
2. Install the libc++ C++ Standard library with sudo apt-get install libc++1.
3. Install Java Runtime 1.7.0_79 or later with sudo apt-get install default-jre.
4. Download the Android SDK and set up the paths accordingly.
5. Extract the Snapdragon Profiler tarball to the preferred directory with tar zxvf SnapdragonProfiler_release_External_Linux.tar.gz.
3.2 Launch Snapdragon Profiler

**NOTE:** Start with Step 5 if the mobile device is already connected to a computer and communicating via ADB.

1. Connect the Android device to a computer where Snapdragon Profiler is installed.

2. Choose **Android Settings > Developer Options** to ensure the device has Developer Options enabled.
   
   a. If **Developer Options** is not visible, go to **Android Settings > About phone > Software info**, and continuously tap the Build number until **Developer Options** is enabled.
   
   b. Go back one step to **Android Settings** to confirm that the **Developer Options** menu item is available.

3. If you don’t have ADB in your path, in Snapdragon Profiler go to **File > Settings** and set the ADB path on the Android tab.

4. On a Windows PC (or terminal on OS X or Linux), open a command prompt and run the **adb devices** command to confirm that the device is recognized (appears in the **List of devices attached**).
   
   a. If ADB does not recognize the device, confirm that the USB connection is in place or ADB has been set up over Wi-Fi. Also verify that the latest ADB USB drivers for the device are installed.
   
   b. If you have problems connecting, confirm that ADB 1.0.32 (or later) is installed. You can check this by typing **adb version** in the command prompt.
   
   c. If ADB recognizes the device, but it shows as Unauthorized, authorize the computer through a pop-up authorization window on the device.
5. Launch Snapdragon Profiler:
   a. For Windows, go to **Start > Programs > Qualcomm > Snapdragon Profiler** or double-click the Snapdragon Profiler desktop icon.
   b. For Mac OS X, go to **Finder > Applications** folder, and double-click **Snapdragon Profiler**.
   c. For Ubuntu Linux, execute the **run_sdp.sh** script from the root Snapdragon Profiler directory.

6. Click **Yes** if asked whether to allow Snapdragon Profiler to send anonymous user statistics.

### 3.3 Connect to a device

1. After launching Snapdragon Profiler, go to **File > Connect**, or from the **Start Page** click the icon to the left of **Connect to a Device** to connect to a device to start a session.
2. The *Connection* window slides from the top of the main window. Snapdragon Profiler auto-detects any devices connected to the computer via ADB, over USB or Wi-Fi, and begins installing the service on the device.

3. If the installation is successful, the *Device* icon is **green** and the Connect button is enabled.

   If the installation fails, the *Device* icon is **red** and the Retry button is enabled. Click **Retry** to try installing the service again.

4. Click **Connect** to connect to the device. A progress wheel displays while Snapdragon Profiler is connecting to the device:
5. If the connection is successful, the \textit{Connection} icon is \textcolor{green}{green}:

If you receive a connection error (the \textit{Connection} icon is \textcolor{red}{red}), click \textbf{Connect} to try again.

\textbf{NOTE:} Mouse over the \textcolor{red}{red} \textit{Connection} icon to get specific details about the error.

6. Once connected, Snapdragon Profiler can be used in three data capture modes: Realtime, Trace Capture, and Snapshot Capture. See Chapter 5 for details on each of these modes.

\textbf{NOTE:} If you have problems connecting make sure ADB 1.0.32 (or later) is installed.
4 User Interface

Snapdragon Profiler provides pre-defined metrics and layouts for one-click setup that lets users quickly capture and view profiled data.

Snapdragon Profiler also enables user-defined metrics and dockable views for customization of the user interface.

4.1 Start Page

Similar to Visual Studio, the Snapdragon Profiler Start Page provides easy access to the primary Profiler functions:

- Connect to a Device
- Realtime profiling
- New Trace Capture
- New Snapshot Capture

4.2 Views

4.2.1 Realtime window

**Figure 4-1 Realtime window**

**NOTE:** The LogCat window is now hidden by default.
4.2.2 Trace Capture window

Figure 4-2 Trace Capture window

4.2.3 Snapshot Trace window

Figure 4-3 Snapshot Trace window
4.3 Navigation

Table 4-1 describes Snapdragon Profiler user interface navigation.

**Table 4-1 Navigation actions**

<table>
<thead>
<tr>
<th>Navigation Action</th>
<th>Purpose/Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drag and drop</td>
<td>To select a category or individual metric to view in the Graph pane</td>
</tr>
<tr>
<td></td>
<td>To rearrange categories and tracks in the Graph pane</td>
</tr>
<tr>
<td>Turn the mouse wheel</td>
<td>To zoom in/out</td>
</tr>
<tr>
<td>Left-click, hold, and move the mouse</td>
<td>To pan</td>
</tr>
<tr>
<td>Click the Timeline</td>
<td>To visualize the time correlation across elements</td>
</tr>
<tr>
<td>Double-click System Metric heading</td>
<td>To add all System metrics to the graph pane and begin profiling</td>
</tr>
<tr>
<td>Ctrl + W</td>
<td>To zoom in on Realtime or Trace Capture mode</td>
</tr>
<tr>
<td>Ctrl + S</td>
<td>To zoom out on Realtime or Trace Capture mode</td>
</tr>
<tr>
<td>Ctrl + A</td>
<td>To pan left when paused in Realtime or Trace Capture mode</td>
</tr>
<tr>
<td>Ctrl + D</td>
<td>To pan right when paused in Realtime or Trace Capture mode</td>
</tr>
</tbody>
</table>
5 Data Capture Modes

This chapter provides an overview of the Realtime, Trace Capture, and Snapshot Capture modes including features and functionality.

5.1 Realtime

Realtime mode, shown in Figure 5-1, allows streaming and viewing real-time performance metrics while an application is running on the Snapdragon-powered device.

Realtime mode plots real-time GPU and system performance data streaming from the embedded graphics driver, including system and process metrics.

System Metrics (categories)

- CPU Core Frequency
- CPU Core Load
- CPU Core Utilization
- GPU General
- GPU Memory Stats
- GPU Shader Processing
- GPU Stalls
- Network - Cellular
- Network – Wi-Fi
- Power
- Primitive Processing
- System Memory
- Thermal
Process Metrics (categories)

- CPU
- EGL (not available for every process)
- GPU General (not available for every process)
- GPU Memory Stats (not available for every process)
- GPU Shader Processing (not available for every process)
- GPU Stalls (not available for every process)
- Memory
- Network
- Primitive Processing (not available for every process)

Figure 5-1 Realtime mode
5.1.1 Realtime basics

1. Check that the Android device is connected to the computer where Snapdragon Profiler is installed and launch the Profiler (see Section 3.2).

2. Choose File > Connect, or from the Start Page, click the icon to the left of Connect to a Device to connect to a device to start a session (see Section 3.3).

3. From the Start Page, click Realtime, or click the Realtime tab to see real-time metrics for an application or device. Real-time metrics can be gathered for CPU, GPU, memory, network, thermal, and power as shown in this view of the Realtime tab:
4. On the left of the **Realtime** tab, **System** metrics can be chosen from the **Metrics** tree view in the **Data Sources** panel.

   To add a new metric graph, double-click the category (to add all the metrics in a category) or individual metric, or drag-and-drop the category or metric into the **Graph** pane on the right.

5. Application, or per-process, metrics can be viewed by first clicking on a process in the **Process** list shown in the top area of the **Data Sources** panel. The **Process** list shows all active user processes.

   **NOTE:** Not all metrics are available for every process.
6. Select a process to see all the metrics available for that process in the Metrics list. Adding process metrics to the Graph pane is the same as with system metrics – double-click, or drag-and-drop, the category or individual metric into the pane.
7. System and process metrics can be viewed in the **Graph** pane at the same time. Multiple processes can also be viewed.

**NOTE:** The more metrics selected and displayed, the more intrusive Snapdragon Profiler is on application performance.
8. If desired click the gear icon in the Graph pane and select Simple and/or Cumulative to display a moving average.

5.2 Trace Capture

Trace Capture mode, shown in Figure 5-2, captures trace events and data available on Snapdragon-powered devices. Once captured, the call trace can be used to:

- Collect and display important performance statistics
- See how threads are scheduled on each of the CPU cores in the Kernel
- See the correlation between CPU, DSP, and GPU activity on the same timeline

Figure 5-2 Trace Capture mode
5.2.1 Trace Capture basics

1. Check that the Android device is connected to the computer where Snapdragon Profiler is installed and launch the Profiler (see Section 3.2).

2. Choose File > Connect, or from the Start Page, click Connect to a Device to connect to a device to start a session (see Section 3.3).

3. From the Start Page, click New Trace Capture, or choose Capture > New Trace.

4. A new Capture tab is created. When this tab is selected, a view similar to Realtime is displayed except traces have Start Capture and Stop Capture buttons.

5. From the Data Sources panel, choose the metrics to view. Choose a process from the Process list to view metrics specific to that process, if any exist.
6. Click **Start Capture** to start the capture.
7. Click **Stop Capture** to stop the capture after a few seconds. Snapdragon Profiler processes and displays the trace data in the **Graph** pane.

**NOTE:** Snapdragon Profiler does not allow trace captures longer than 10 seconds.
5.2.2 Measure DSP performance

To collect DSP data, a device with a Snapdragon 820 processor such as a Samsung Galaxy S7 must be used.

1. Check that the Android device is connected to the computer where Snapdragon Profiler is installed and launch the Profiler (see Section 3.2).
2. Choose File > Connect, or from the Start Page click Connect to a Device to connect to a device to start a session (see Section 3.3).
3. From the Start Page, click New Trace Capture, or choose Capture > New Trace to view trace-level performance data for the application or device.
4. From the Metrics window, expand the System category if needed, two subcategories are displayed: Trace and DSP. Trace collects data from the Android system trace and DSP collects data from the device DSP.
5. Select the metrics for the capture:
   a. Expand the DSP subcategory to view the available metrics. Scroll to DSP % Utilization and check the box to enable this metric.
   b. Expand the Trace subcategory and enable the CPU Frequency and HW Modules metrics.

Collecting DSP and Trace metrics will demonstrate Profiler’s ability to correlate Timeline information across different processor subsystems.

NOTE: To see a change in the DSP % Utilization, an app that produces audio needs to be turned on during the capture.

6. Click Start Capture in the top left corner to start the capture.
7. A few seconds into the capture, turn on the audio on.
8. Let the audio play for a few seconds and then click Stop Capture. The capture can be continued, however it automatically stops capturing after 10 seconds.
9. The capture data displays in the main Profiler window.
    □ Notice that a few seconds into the capture, the DSP % Utilization increased due to the audio activity.
    □ Notice the activity increase in the Trace data during the time the audio was running.
10. Use the bookmark feature to easily see correlation across timelines.

5.2.3 Capture OpenCL applications

Use Trace Capture to understand how an OpenCL application performs on a device powered by a Snapdragon processor.

NOTE: Not all mobile devices support OpenCL. Use an app like OpenCL Info to see if OpenCL is supported on your device. Depending on the application being captured and the preferred behavior, additional setup steps may be required before running an app.
1. Check that the Android device is connected to the computer where Snapdragon Profiler is installed and launch the Profiler (see Section 3.2).

2. Choose **File > Connect**, or from the **Start Page** click **Connect to a Device** to connect to a device to start a session (see Section 3.3).

3. If the application to be captured is command line, and capture from the beginning is preferred, the **Enable Blocking** option must be set before running the application. Once set, the application pauses execution until the capture begins.

   **NOTE:** An OpenCL preset layout is available for easy access to all OpenCL-relevant views.

4. From the **Start Page**, click **New Trace Capture**, or choose **Capture > New Trace** to view trace-level performance data for an application or device.

5. From the **Process** list, choose the application. An **OpenCL Trace** metric appears in the **Metrics** tree view.

6. Enable the **OpenCL Trace** metric and the other OpenCL metrics to capture.

7. Click **Start Capture** in the top left corner to start the capture.

   **NOTE:** If the app being captured is command line, execution resumes on the given app.

8. Click **Stop Capture** to end the capture. If the application finishes executing, the capture stops automatically.

9. The data is then transferred and processed. A progress indicator displays in the bottom right corner of the Profiler window.

10. When processing completes, the Trace Capture data displays in the main Profiler window, organized by thread on the host, and by context and device on the GPU.

   □ **Event links**
   
   Correlation links are shown between calls that either wait or complete events.

   □ **Trace elements**
   
   Select trace elements to view detailed information about the element in Trace view.

   □ **Buffer visualization**
   
   If buffer and image data transmission was enabled, an additional track displays with markers where data bound to the given buffers might have been modified.

   □ **Buffer snapshots track**
   
   Click a marker to view this data and look at the selected buffer data on the buffer or image viewer.

   □ **Buffer viewer**
   
   The Buffer viewer can be customized to suit the data being viewed. The number of rows and columns per page can be modified to align the data and the display format can be changed to match the most common use cases.

   □ **Trace view**
   
   Trace data with API calls return values, parameters and metric calculations appears in the Trace view. Metrics are only calculated on relevant calls.
Resources and Inspector views
The Resources view lists all resources gathered during the capture. Click a resource to display details about the resource in Inspector view.

Programs display static code analysis within Inspector view as well as the containing kernels within the source view.

5.3 Snapshot Capture

Snapshot Capture mode, shown in Figure 5-3, allows the capture of a single frame of a graphics application. Snapshot Capture shows in detail how a scene is being rendered on the CPU.

In Snapshot Capture, choose a process to see the available metrics. Then select the metrics to view, and take a snapshot. Once the frame is captured, view the captured data and step through the frame rendering draw call-by-draw call.

![Figure 5-3 Snapshot Capture mode](image)

5.3.1 Snapshot Capture basics

1. Check that the Android device is connected to the computer where Snapdragon Profiler is installed and launch the Profiler (see Section 3.2).

   **NOTE:** Snapdragon Capture mode currently only works on mobile devices with a Qualcomm Snapdragon 805 (or later) processor and Android 6.0 (or later)

2. Choose File > Connect, or from the Start Page, click Connect to a Device to connect to a device to start a session (see Section 3.3).
3. From the **Start Page**, click **New Snapshot Capture**, or choose **Capture > New Snapshot**.

4. A new **Snapshot** tab is displayed:

5. From the **Snapshot** tab, scroll through the **Data Sources** list and choose a process.

6. The metrics available for the process appear in the **Processes** list on the lower left.
7. Click the metrics to view in the snapshot, then click **Snapshot Capture** to capture the frame.

8. An **orange bar** indicates the Profiler is retrieving the snapshot.

9. Once captured, view the captured data and step through the frame rendering drawcall-by-drawcall.
6 Troubleshooting

This chapter provides answers to common questions about using Snapdragon Profiler. If the issue is not addressed here, submit a question on the Qualcomm Developer Network, Snapdragon Profiler Support Forum at: https://developer.qualcomm.com/forums/software/snapdragon-profiler

Why can’t I connect to my device?

To resolve this issue:

1. Open a command prompt or terminal and confirm that the device is set up for ADB by running the `adb devices` command,

2. The device should display in the List of devices attached with a status of device (see Section 3.2).

3. Type `adb version` in the command prompt to confirm that ADB version 1.0.32 or later is installed.

Snapdragon Profiler relies on ADB to discover the connected devices. If ADB connection has been eliminated as the issue, contact us on the Qualcomm Developer Network, Snapdragon Profiler Support Forum at: https://developer.qualcomm.com/forums/software/snapdragon-profiler

Why doesn’t the track have any data when I choose a real-time metric?

If a metric is chosen that doesn’t trigger system events to generate data, Snapdragon Profiler doesn’t display any data.

Why don’t I see any data when I run a Trace Capture?

This is a known issue. Try restarting Snapdragon Profiler to resolve it.

Why does nothing happen when I choose my application and run a Snapshot Capture?

Snapdragon Profiler interfaces with the graphics driver to query the information gathered in a Snapshot for a rendered frame. Some devices may not have the driver updates required to gather this data and properly support snapshots. Android 6.0 (or later) is required to use this feature.
Why don’t I see FPS on my device?

To view the FPS:
1. Select the process to see new categories in the Metrics list.
2. Expand the EGL category and FPS should be one of the metric options.

Note: FPS only works on OpenGL ES apps running on Snapdragon 805 (or later) mobile devices.

Why don’t I see Vulkan metrics?

To resolve this issue:
- Make sure ADB is accessible in the system PATH.
- Confirm the Vulkan libraries are in the right location and write permissions are enabled.
- Confirm the device is a supported device running Android N (or an Android 6.0 device with a graphics driver that supports Vulkan)
- Start the app after connecting to Snapdragon Profiler.