Technical Guide

Updated August 24, 2018

HOW TO BENCHMARK YOUR DEVICE

VRMark is a benchmarking application for measuring VR performance. The Android version works with or without a headset to help you test and compare the VR performance of the latest smartphones.

VRMark Professional Edition, designed for industry and press use, combines three VR benchmarks with three test modes to provide a comprehensive set of tools for testing the VR capabilities of Android devices.

For VR enthusiasts at home, a free version of the app offers a smaller set of VR benchmark tests and experiences.

> ⚠ This guide is for the Android version of VRMark. There is a separate guide for the Windows version.

Your privacy

VRMark uses app analytics and crash reporting to collect anonymous data that helps us improve the performance, stability, and usefulness of the app.

VRMark does not collect or use any personally identifiable data, but you can disable these services on the app's Settings screen if you wish.

Please read our Privacy Policy to learn about the data we collect, how we use that data, and how you can access and update information we hold about you.

CHOOSE A BENCHMARK

VRMark is designed around benchmark tests, which we call Rooms. A Room is a piece of VR content that has been carefully created to require a specific level of VR performance. There are three Rooms in the Android version of VRMark. For each Room, VRMark offers three ways to test VR performance.

Indigo Room

The Indigo Room test represents the majority of mobile VR content available today. It is a lightweight test that is designed to run comfortably for long periods on first-generation Daydream devices.

Purple Room

The Purple Room benchmark is designed to run well for at least one loop on first-generation Daydream devices. Some phones will get hot when looping this test, and their performance may fall as the test runs.

Amber Room

The Amber Room is a forward-looking test that represents next-generation mobile VR content. It is a demanding test that is ideal for comparing devices that already perform well in the other Rooms.

CHOOSE A TEST MODE

Peak Mode

Peak Mode measures a device's peak performance by running a single loop of the benchmark test. This mode tells you how well a device can handle VR content for a short period of time, which is the best-case scenario for any device. A VR headset is not required.

In Peak Mode, the benchmark runs on a fixed path, which makes it easy to repeat the test on other devices. Peak Mode gives your device a score and other metrics that you can use to compare devices.

Sustained Mode

Use Sustained Mode to test VR performance over longer periods. You can choose to run the test for 10 loops, one hour, one day, or one week. Sustained Mode helps you uncover thermal and stability issues that affect device performance. A VR headset is not required.

The benchmark runs on a fixed path, which makes it easy to repeat the test. Sustained Mode gives your device a score and other metrics that you can use to compare devices. It will also give you an estimate of the device's VR battery life.

Experience Mode

Use Experience Mode to judge the quality of the VR experience with your own eyes. Devices use clever techniques to compensate for missed frames and low frame rates. Connect a headset and see for yourself as you explore the Room. Experience Mode does not produce a score or other metrics.

VRMark supports Daydream View and Google Cardboard compatible headsets. If you have a Daydream-ready device, install the Google VR Services app in order to use VRMark with a Daydream View headset.

CHOOSE A VR PLATFORM

VRMark supports Daydream View and Google Cardboard compatible headsets. Samsung Gear VR is not supported. A headset is not required to run VRMark benchmark tests.

The test content is the same whichever platform you choose. Benchmark scores are not affected by your choice of VR platform.

Daydream View

If you have a Daydream View headset and a Daydream-ready device, you can use VRMark in Daydream mode.

Initial setup

1. Download and install the VRMark app and its test content.
2. Download and install the Google VR Services app from Google Play.
3. Download and install the Daydream app from Google Play.
4. Turn NFC on in your device's Wireless and Network settings.
5. Pair your Daydream View headset with your device.
6. In VRMark, open VR Settings, tap Headset, then select Daydream View.
7. Pair the Daydream controller with your device.

Peak Mode and Sustained Mode

1. Tap on the Run icon in the VRMark app.
2. Place your phone into your Daydream View headset.
3. Press the Daydream button to wake the controller.

> ⚠ For your own comfort, you should not wear your headset while running a benchmark in Peak or Sustained Mode.

Experience Mode

There are two ways to use Experience Mode with a Daydream View headset.

Option 1

1. Place your phone into your Daydream View headset.
2. Press the Daydream button to wake the controller.
3. From the Daydream Library, select VRMark.
4. Select Indigo, Purple, or Amber Room Experience Mode with the controller or by gazing at the appropriate image.
5. To exit Experience Mode, press the Back button on the controller.

Option 2

1. In VRMark, on the My Tests screen, tap on VR headset icon for the test.
2. Place your phone into your Daydream View headset.
3. Press the Daydream button to wake the controller.
4. The selected test will start in Experience Mode.
5. To exit Experience Mode, press the Back button on the controller.

If you wish to use VRMark in Google Cardboard mode with a Daydream View headset, you should open VR Settings, tap Headset, then select Google Cardboard in the VR Settings of your device.

Google Cardboard

If your device is not preconfigured to run in Daydream mode, VRMark will use Google Cardboard mode. A headset is not required.

Initial setup

1. Download and install the VRMark app and its test content.
2. In VRMark, open VR Settings, tap Headset, select Google Cardboard.

Peak Mode and Sustained Mode

1. Tap on the Run icon in the VRMark app.
2. Place your phone into your Google Cardboard compatible headset.

Experience mode

In VRMark, open VR Settings, tap Headset, then select Google Cardboard.

1. In VRMark, on the My Tests screen, tap on VR headset icon for the test.
2. To exit Experience Mode, click the X icon in the top left of the screen.

GOOD TESTING GUIDE

To get accurate and consistent benchmark results you should test clean devices without third-party software installed. You should close other apps that may be running in the background and disable notifications before running the benchmark.

Some high-powered mobile devices use CPU throttling to avoid overheating, which can lead to lower scores on successive runs. To reduce this effect, we recommended waiting 15 minutes before and after VRMark runs to allow the device to cool down.

- Running other apps during the benchmark can affect the results.
- Don't touch the screen while the test is running.
- You can cancel a test by pressing the Back Button.

Recommended process

1. Ensure your device's operating system and VR services are up to date.
2. Close other apps.
3. Run the benchmark.

Expert process

1. Ensure your device's operating system is up to date.
2. Restart the device.
3. Wait 2 minutes for startup to complete.
4. Close other apps, including those running in the background.
5. Wait for 15 minutes.
6. Run the benchmark.
7. Repeat from step 2 at least three times to verify your results.

VRMARK EDITIONS

VRMark Professional Edition, designed for industry, press, and analyst use, combines three VR benchmark tests with three test modes to provide a comprehensive set of tools for testing the capabilities of the latest devices.

For VR enthusiasts at home, a free version of the app offers a smaller set of VR benchmark tests and experiences.

	CONSUMER APP	PROFESSIONAL EDITION
Licensed for Commercial Use	×	•
Indigo Room Peak Mode	×	•
Indigo Room Sustained Mode	×	•
Indigo Room Experience Mode	•	•
Purple Room Peak Mode	×	•
Purple Room Sustained Mode	10 loops	•
Purple Room Experience Mode	•	•
Amber Room Peak Mode	•	•
Amber Room Sustained Mode	×	•
Amber Room Experience Mode	•	•
Hardware monitoring	•	•
Compare devices in-app	•	•
Automation over adb	×	•
Support	Online	Email & phone
Price	Free	From $499

SUPPORTED LANGUAGES

The VRMark app supports the following languages:

- English
- Finnish
- German
- Russian
- Simplified Chinese

You can change the language used in the VRMark app by changing your device language from the main Android settings.

SYSTEM REQUIREMENTS

OS	Android 7.0 or later
PROCESSOR	ARM-based
RAM	1 GB
API	OpenGL ES 3.1 or OpenGL ES 3.0 with MSAA support

VRMark supports Daydream View and Google Cardboard compatible headsets, but a headset is not required to run the benchmark tests.

HOW TO USE THE VRMARK APP

The app has four main sections, which you can move between using the navigation bar at the bottom of the screen.

- My tests
- My results
- My device
- Compare

Tutorial

After opening VRMark on your device for the first time, a short tutorial will explain the four main parts of the app.

You can skip the tutorial by pressing **Skip** in the upper-right corner of the screen. You can open the tutorial again from the Settings screen.

Sharing your results

VRMark makes it easy to save and share your results, comparisons, and other screens in the app. Whenever you see the share icon, tap it to share an image of the current card.

MY TESTS

Install your tests

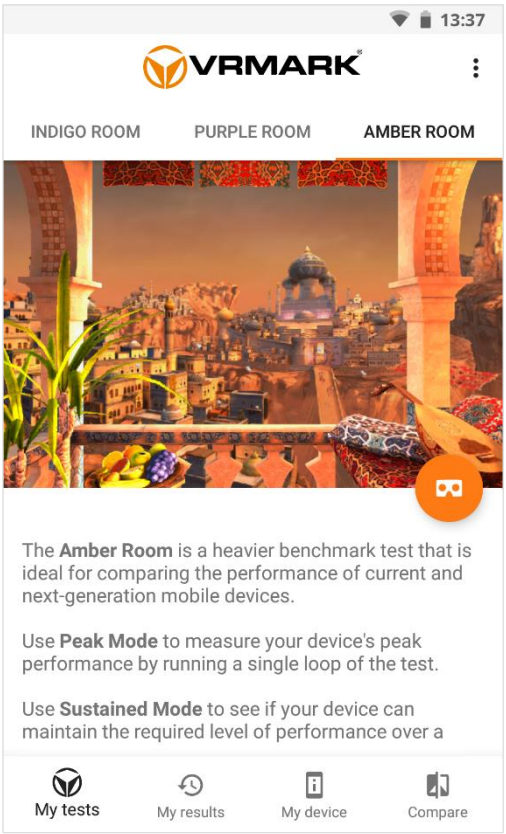
VRMark has three benchmark tests, which must be downloaded and installed from within the app before you start benchmarking.

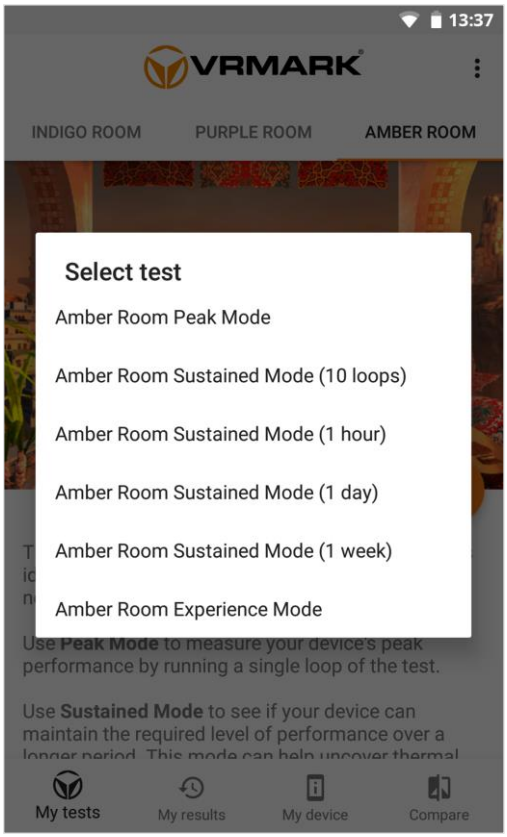
Tests that are not installed have a monochrome image. To install the tests, tap the orange download icon. After a test is installed, its image is in color.

Run a test

Professional Edition app

1. Select the Room you want to use by swiping left or right.
2. Tap the orange headset icon on the right below the test image.
3. Select the test mode you wish to use.

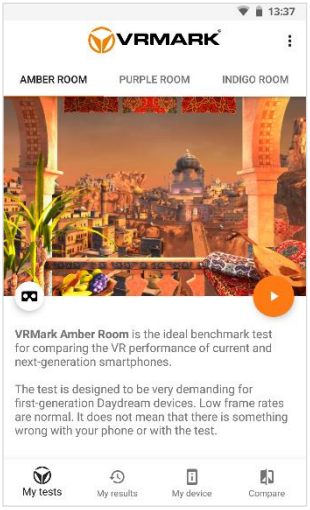


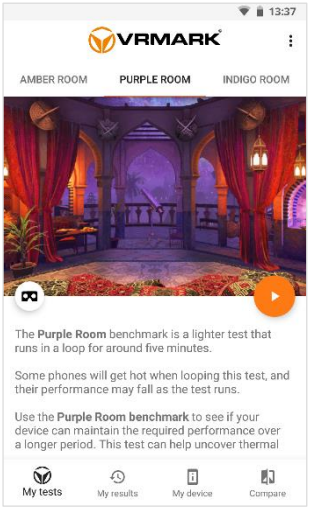


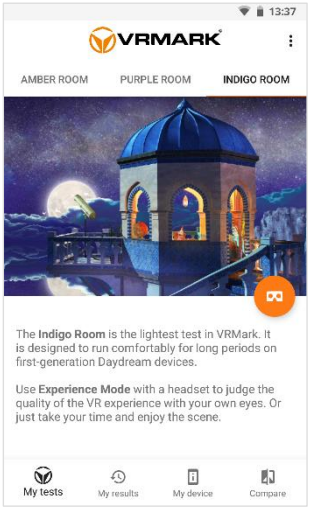
Consumer app

The free consumer app works differently since it has fewer test options.

1. Select the Room you want to use by swiping left or right.
2. Tap an icon to start the test according to the table below.



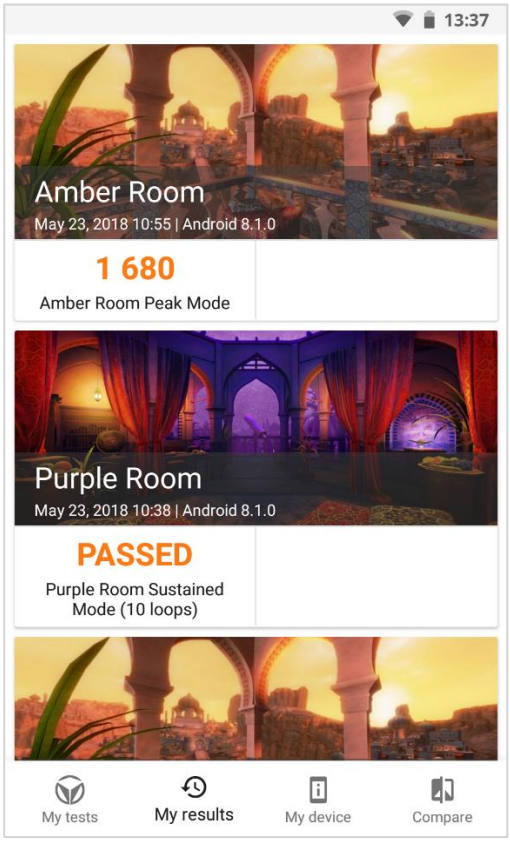


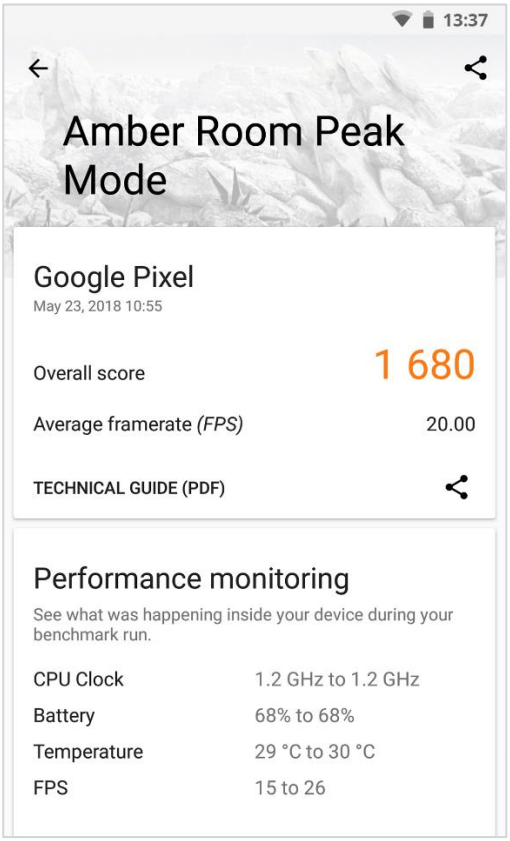


	WHITE ICON (LEFT)	ORANGE ICON (RIGHT)
AMBER ROOM	Experience Mode	Peak Mode
PURPLE ROOM	Experience Mode	Sustained Mode (10 loops)
INDIGO ROOM	n/a	Experience Mode

MY RESULTS

This screen lists all the benchmark runs from your device, (left image).





Tap a result card to open it and see the detailed result view, (right image).

Result view

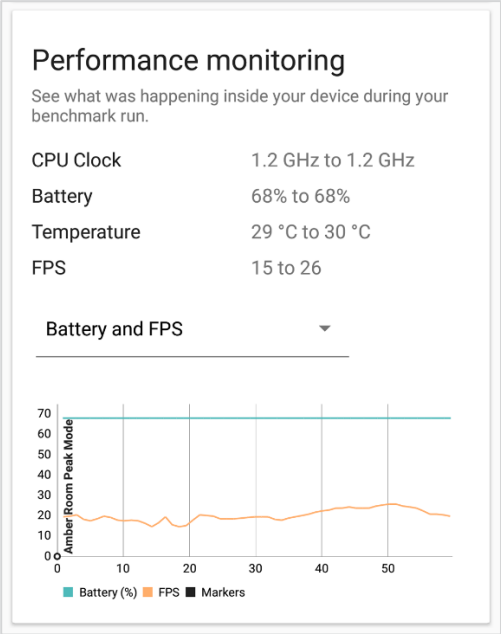
The first card in the Results view shows you your main score and additional sub-scores when relevant. See later in this guide for an explanation how the scores are calculated.

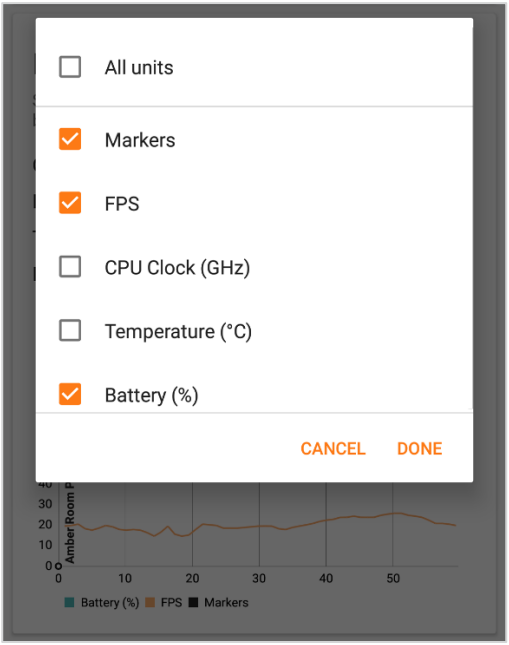
Performance monitoring

This card shows you what was happening inside your device during your benchmark run.

The data above the chart shows the minimum and maximum values from your run. The chart shows you how those values changed during the run.

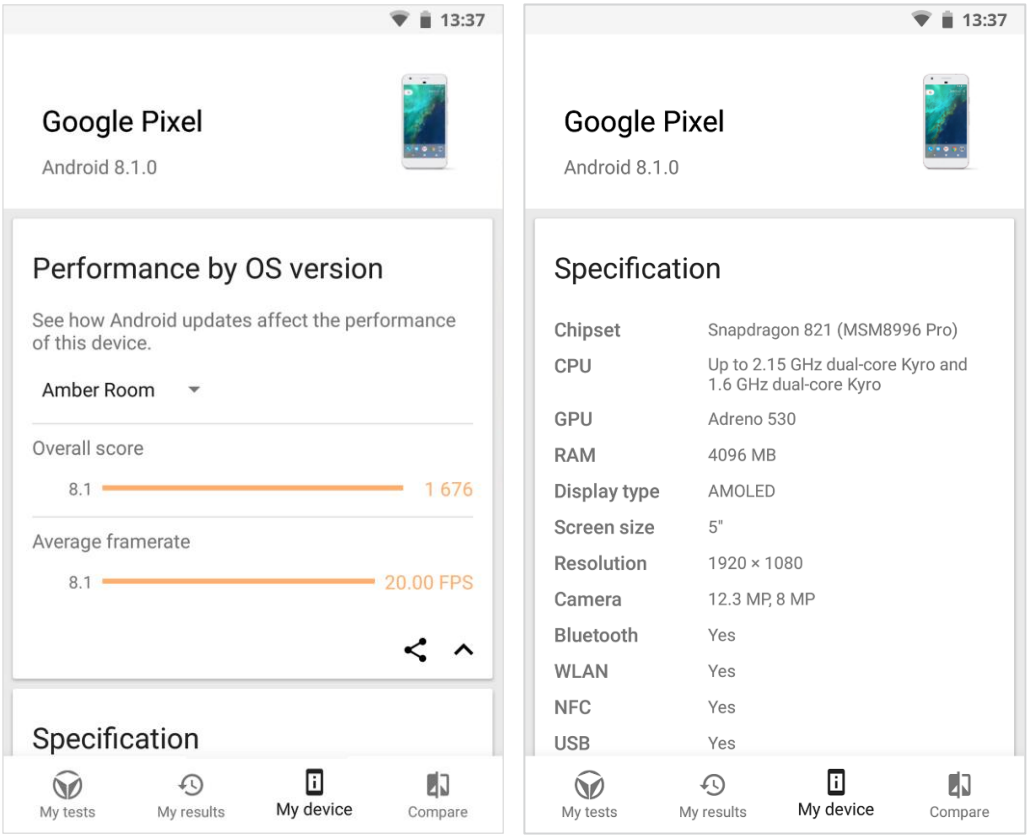
You can choose from a few preconfigured chart combinations, such as Battery and FPS, or create your own custom chart view.


Performance monitoring
See what was happening inside your device during your benchmark run.
CPU Clock 1.2 GHz to 1.2 GHz
Battery 68% to 68%
Temperature 29 °C to 30 °C
FPS 15 to 26
Battery and FPS
Amber Room Peak Mode
Battery (%) FPS Markers


All units
Markers
FPS
CPU Clock (GHz)
Temperature (°C)
Battery (%)
CANCEL
DONE
Battery (%) FPS Markers

MY DEVICE

This part of the app helps you learn more about your device.



Performance by OS version

This card shows how Android OS updates have affected the performance of your device. The chart shows the average benchmark score for each OS version available for your device.

You can select different benchmark tests from the drop-down list. You can expand the card with the drop-down menu to see the charts for the average frame rate.

Specification

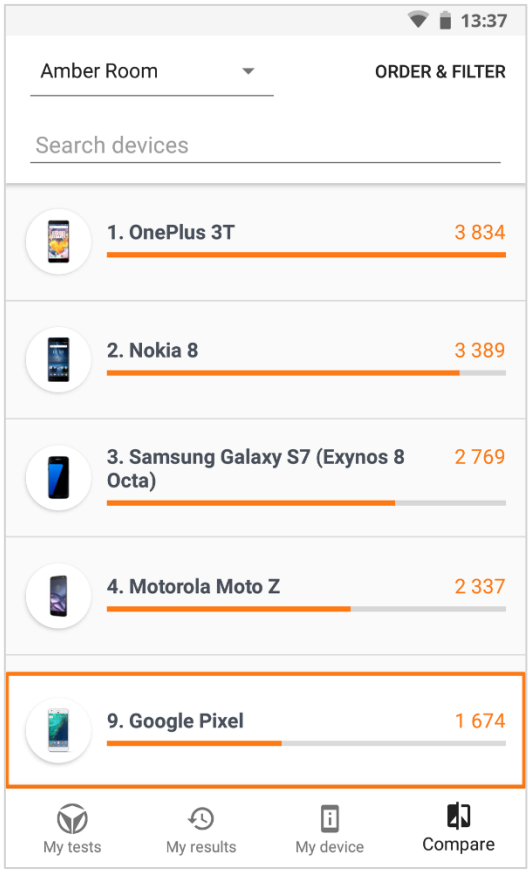
This card shows the main technical specifications of the device, from its hardware (SoC, CPU, GPU, RAM, storage) to screen (type, size, resolution) to physical properties (dimensions, weight) and much more, all on one screen.

COMPARE

This part of the app helps you choose a new smartphone by comparing the latest models. You can search, filter, and sort our list of the best devices. Use this list to find and compare the best devices for VR.

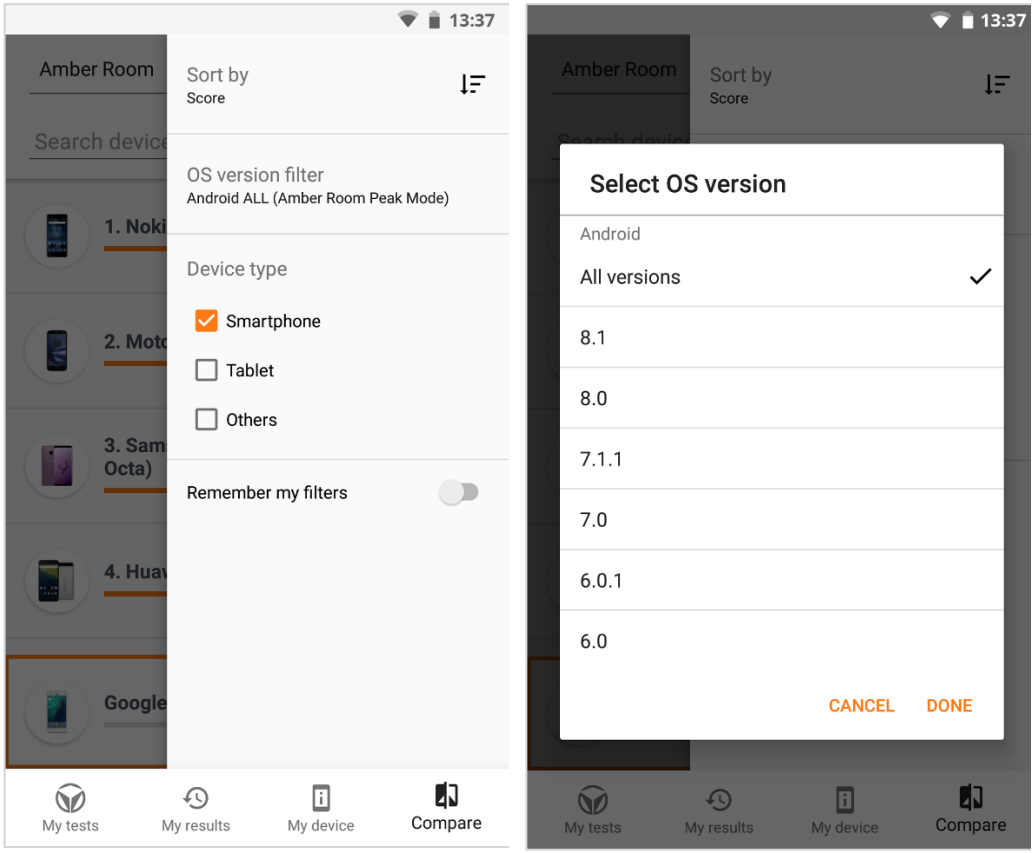
You can search for a device by name or by scrolling through the list. To make comparing easier, the average score and rank for your own device is always visible near the bottom of the screen.

To find out more about a device, tap on its row to open a detailed view that is similar to the My Device screen.



Compare list options

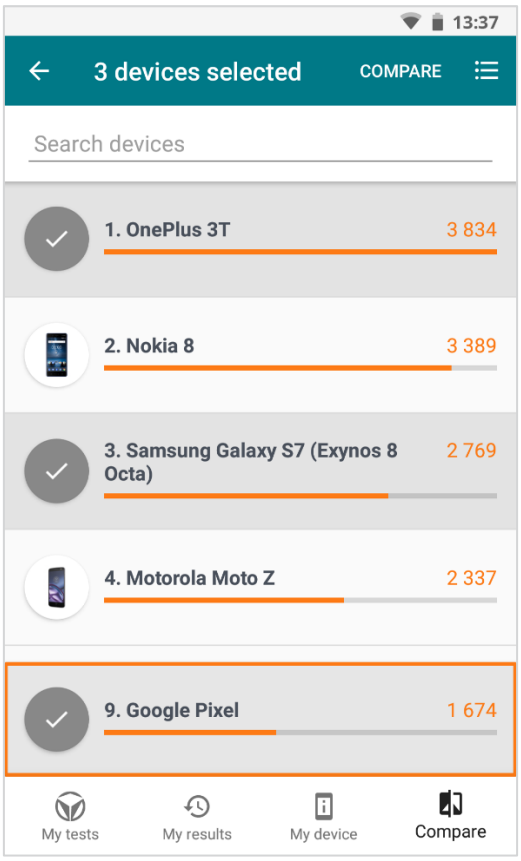
Tap on **Order & Filter** to open the options menu for the list. From the top, you can choose to sort the list by **score** or alphabetically by device **name**. Tap the sort icon in the top-right to swap between ascending and descending order.



Tap on **OS version filter** to select specific OS versions to include in the Compare list. You can also remember your filters for future reference.

How to compare two or more devices

It's easy to compare devices with VRMark. Tap on the device images to select up to five devices and then click compare at the top of the screen.



The chart from the comparison view shows how the devices' average scores compare. You can expand the card with the drop-down arrow to see the average frame rate comparison.

You can also see the differences in hardware and specifications. Comparing models has never been this easy.

Settings

Open Settings from the menu icon in the top-right corner of the My Tests screen.

Settings

Application

Shows the version number of the app.

Benchmarks

Open the **Available tests** drop-down to see a list of all tests and their version numbers. You can also install and uninstall tests from this screen.

Support

You can repeat the **Tutorial** or tap **Report a problem** to get help from our support team.

VRMark does not collect or use any personally identifiable data, but you can choose to enable and disable the options to **Send crash reports** and **Send Analytics**.

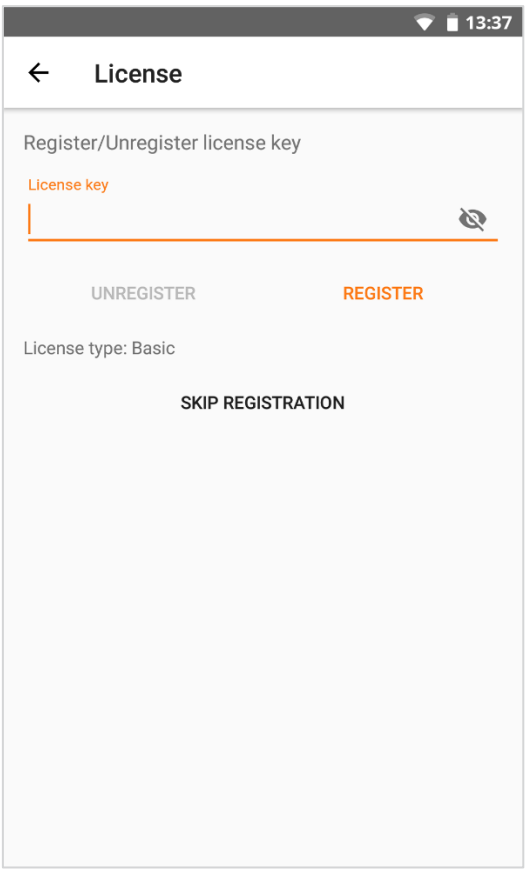
VR settings

You need to have installed the Google VR Services app to enable VR settings.

You can choose which type of headset you want to use by tapping on **Headset**. VRMark supports Daydream View and Google Cardboard compatible headsets, but a headset is not required to run the tests.

License

VRMark Professional Edition requires a license key. The key can be **registered** or **unregistered** on the License screen in Settings.



To register the key, introduce the license key in the key field and hit Register. Unregistering will reset application to Basic License.

Note that the Professional Edition keys have an expiration date. Contact us at UL.BenchmarkSales@ul.com when your key is about to expire.

Privacy Policy

Tap on **Privacy Policy** to open and read our Privacy Policy in your browser.

VRMARK INDIGO ROOM

The Indigo Room test represents the majority of mobile VR content available today. It is a lightweight test that is designed to run comfortably for long periods on first-generation Daydream devices.

Target frame rate

Daydream-ready smartphones should be able to run the Indigo Room benchmark at a consistent 60 frames per second.

Implementation

The Indigo Room features geometry processing, efficient illumination, and GPU simulated particles using transform feedback. The test uses a forward-rendering method with prebaked lightmaps. The engine uses 2× MSAA anti-aliasing. Post-processing is limited to simple tone mapping. To avoid rendering twice (once per eye) a multiview feature is used if supported.

With Daydream View, the benchmark uses the Google VR SDK to implement asynchronous reprojection and distortion of the eye buffers.

The rendering resolution is 3072 × 1536, which is 1536 × 1536 per eye.

Professional Edition app

- Peak Mode
- Sustained Mode
- Experience Mode

Consumer app

- Experience Mode

VRMARK PURPLE ROOM

The Purple Room benchmark is designed to run well for at least one loop on first-generation Daydream devices. Some phones will get hot when looping this test, and their performance may fall as the test runs.

Target frame rate

First-generation Daydream-ready devices should be able to run the Purple Room benchmark at 60 FPS for at least one loop.

Implementation

VRMark Purple Room features geometry processing, efficient illumination and GPU simulated particles using transform feedback. The test uses a forward-rendering method with prebaked lightmaps. The Purple Room has one dynamic point light. The engine uses 2× MSAA anti-aliasing. Post-processing is limited to simple tone mapping. To avoid rendering twice (once per eye) a multiview feature is used if supported.

With Daydream View, the benchmark uses the Google VR SDK to implement asynchronous reprojection and distortion of the eye buffers.

The rendering resolution is 3072 × 1536, which is 1536 × 1536 per eye.

Professional Edition app

- Peak Mode
- Sustained Mode
- Experience Mode

Consumer app

- Sustained Mode (10 loops)
- Experience Mode

VRMARK AMBER ROOM

The Amber Room is a forward-looking test that represents next-generation mobile VR content. It is a demanding test that is ideal for comparing devices that already perform well in the other Rooms.

The Amber Room is very demanding for first-generation Daydream devices. Low frame rates are normal. It does not mean that there is something wrong with the device or the test.

Target frame rate

First-generation Daydream-ready devices should achieve 20-30 FPS.

Implementation

VRMark Amber Room features geometry processing, efficient illumination and GPU simulated particles using transform feedback. The test uses a forward-rendering method with prebaked lightmaps. The Amber Room uses four dynamic point lights and one directional light with a 2048 × 2048 shadow map. The engine uses 2× MSAA anti-aliasing. Post-processing is limited to simple tone mapping. To avoid rendering twice (once per eye) a multiview feature is used if supported.

With Daydream View, the benchmark uses the Google VR SDK to implement asynchronous reprojection and distortion of the eye buffers.

The rendering resolution is 3072 × 1536, which is 1536 × 1536 per eye.

Professional Edition app

- Peak Mode
- Sustained Mode
- Experience Mode

Consumer app

- Peak Mode
- Experience Mode

TECHNICAL COMPARISON

	INDIGO ROOM	PURPLE ROOM	AMBER ROOM
VERTICES	46,981	102,147	344,573
TRIANGLES	58,828	100,552	452,463
AVERAGE VISIBLE TRIANGLES	~21,000	~32,000	~202,000
DYNAMIC LIGHTS	-	1 point light	4 point lights, 1 directional light with shadows
LIGHTMAPS	Yes	Yes	Yes
TEXTURES	43.9 MB	65.65 MB	70.5 MB
RENDER TARGETS	Up to 112.5 MB	Up to 112.5 MB	Up to 112.5 MB

VRMARK ENGINE

VRMark uses a custom graphics engine developed in-house to ensure there is no bias towards a particular vendor.

Source code access is available to members of our Benchmark Development Program. Contact UL.BenchmarkBDP@ul.com for details.

Graphics API

The VRMark engine uses OpenGL ES 3.1 with multisampled framebuffer objects, vertex array objects, and uniform buffers. Draw calls are sorted to reduce state changes and API calls. When OpenGL ES 3.1 is not available on the device, the engine can use OpenGL ES 3.0 with multisampled framebuffer support. The engine uses ETC2 texture compression.

Pipeline

The engine pipeline is optimized for VR. Scene update, particle simulations, and geometry visibility solving and culling are executed only once per frame, and the results are shared for both eye views. All other rendering passes are executed per eye view, unless the multiview path is enabled.

Multithreading

The scene update is multithreaded using one thread less than the number of available physical CPU cores. The aim is to reduce the CPU load by utilizing multiple cores, but leave one physical core free for the display driver. None of the Rooms are CPU bound.

Forward lighting

Traditional forward lighting is used for shading. Shading supports one shadowed directional light and up to 32 unshadowed point lights. All lights are rendered in one pass directly into the API-provided eye buffers.

Lightmaps

To reduce fragment shader load, only animated lights are drawn dynamically. Static lights are baked into lightmaps.

Multiview

Multiview is enabled by default. If available, the engine will use the GL_OVR_multiview2 extension with 2 views (1 view per eye) to reduce the amount of draw calls. If some drivers do not support GL_OVR_multiview2 then the engine falls back to drawing once per eye.

Particles

Particle effects are rendered on top of the opaque surface illumination with additive or alpha blending. Particles are simulated on the GPU using transform feedback and are simply self-illuminated.

Multi-sample anti-aliasing (MSAA)

The forward renderer uses traditional 2× MSAA or 4× MSAA for solving aliasing. MSAA is required.

Post-processing

Post-processing is limited to simple tone mapping.

BENCHMARK SCORES AND RESULTS

Depending on the test mode, VRMark produces either a score or a Pass/Fail.

> ⚠ Scores from the Indigo Room, Purple Room and Amber Room should not be compared with each other. They are separate tests, and each one produces its own score.

Peak Mode

Peak Mode produces an overall score, which can be used to compare devices. The test result also includes the average frame rate during the test.

$$Overall\ score = averageFPS \times scoreMultiplier$$

Where:

$averageFPS$	=	The average frame rate
$scoreMultiplier$	=	A scaling constant set to 83.3

The *scoreMultiplier* scaling constant is used to bring the score in line with traditional UL benchmark score levels.

Sustained Mode

Sustained Mode produces a **Pass/Fail** result. A device must maintain an average frame rate of at least 58.0 FPS for every loop of the test to pass.

The **Sustained loops** result is the percent of loops that met or exceeded the frame rate target.

Sustained Mode tests in the Professional Edition app also produce Battery Life results. The **Battery life** result is an estimate of the device's battery life for VR. The **Battery life confidence** result is app's confidence in the battery life estimate. It can be low, medium, or high.

Experience Mode

When the frame rate falls short of the 58.0 FPS target, we recommend trying Experience Mode with a headset.

Device can use clever techniques to compensate for missed frames and low frame rates. Even when the average frame rate is below the target, you may be surprised by the quality of the experience in Experience Mode.

The Experience mode does not produce a score or other results.

HOW TO REPORT SCORES

VRMark includes three VR performance benchmarks, each representing a different quality level of VR content. The scores from each test are not comparable. Use the full name of the test and the test mode when reporting your benchmark scores. Do not use VRMark as a unit of measurement.

✓ "Device scores 2,000 in the VRMark Amber Room benchmark (Peak Mode)."
× "The smartphone scores 2,000 VRMarks."

✓ "The device passed the VRMark Purple Room benchmark running in Sustained Mode for 1 hour."
× "The smartphone passed the VRMark Purple Room benchmark."

Always include details of the device used to obtain the score. Be sure to include the Android OS version and the exact device model.

Using VRMark scores in reviews

We provide complimentary Professional Edition benchmarks to members of the press working for established and reputable publications. Contact us at UL.BenchmarkPress@ul.com to request a VRMark key for your publication.

You may monetize video reviews that include VRMark video or screenshots. But please do not use YouTube's ContentID system, or other similar systems, to claim copyright ownership of videos that include UL material.

We kindly ask you to include a link to https://benchmarks.ul.com/ whenever you use our benchmarks in a review, feature or news story.

Using VRMark scores in marketing material

For business purposes, a commercial license is granted with the purchase of VRMark Professional Edition or through our site licensing program.

⚠ You must not disclose or publish VRMark benchmark test results, nor may you use the UL logo or other UL assets in your sales and marketing materials, without prior, written permission from UL. Please contact UL.BenchmarkSales@ul.com for details.

On the first mention of VRMark in marketing text, such as an advertisement or product brochure, please write "VRMark® benchmark" in order to protect our brand trademark. For example:

"We recommend VRMark® benchmarks from UL."

Please include our legal text in your small print.

"VRMark® is a registered trademark of Futuremark Corporation."

AUTOMATION WITH ADB

VRMark Professional Edition license holders can use adb (Android Debug Bridge) to automate the benchmark process.

If you already have a license, please contact UL.BenchmarkSales@ul.com to request the files and scripts mentioned in this guide.

LICENSE KEY ACTIVATION

VRMark automation requires a valid Professional Edition license key.

The license can be activated persistently in the app or temporarily made available at runtime for automation runs, (depending on the license type).

	BDP DEVELOPER LICENSE	SITE LICENSE	PROFESSIONAL EDITION
KEY FORMAT	`VRMA-DEV-*`	`VRMA-PROS-*`	`VRMA-PRO-*`
AUTOMATICALLY INSTALL TESTS	●	●	●
RUN ALL TESTS	●	●	●
PERSISTENT ACTIVATION	offline	offline	online
RUNTIME ACTIVATION	●	●	×
LICENSE KEY FILE ACTIVATION	●	●	×
PRIVATE OFFLINE MODE[1]	●	●	×

Persistent activation

VRMark licenses can be activated persistently on a device in several ways:

- Manually enter the license key on the License screen in the app.

[1] Private offline mode disables result submission, app analytics, crash reporting, and all other app network use.

- Run the following intent, replacing the XXXX text with your own license key, through adb to start the application launcher and automatically activate the license:

```
adb shell "am start -a android.intent.action.MAIN -n
com.ul.benchmarks.vrmark/com.futuremark.flamenco.ui.splash.Spl
ashPageActivity -e com.futuremark.android.LICENSE_KEY VRMA-
XXX-XXXXX-XXXXX-XXXXX-XXXXX"
```

- With a BDP Developer license or a Site License, upload a text file named `key.txt` containing the license to `/sdcard/VRMarkAndroid/key.txt` (the file will be removed after activation)

Temporary Runtime Activation

BDP Developer licenses and Site Licenses can be temporarily activated for automation by including them in the .xml settings passed in the intent.

```
<?xml version="1.0" encoding="UTF-8"?>
<benchmark>
<product>vrma</product>
<test_info>
	...
</test_info>
<settings>
	<setting>
		<name>license_key</name>
		<value>XXXX-XXX-XXXXX-XXXXX-XXXXX-XXXXX</value>
	</setting>
</settings>
</benchmark>
```

LAUNCHING BENCHMARKS WITH ADB

You can start a VRMark benchmark run using the adb command line tool provided with the Android SDK. Please refer to the Android SDK documentation on how to run the adb command and connect to a device in debugging mode.

Setup

Note 1: For the provided .xml examples to work, you need to create a folder called `VRMarkAndroid` on the external storage of your device.

Note 2: Before it is possible to run benchmark, the benchmark tests need to be installed. This is done by copying the benchmark's DLC package to the device's external storage (for example the `/sdcard` folder). There is a single package that contains data for the Indigo, Purple and Amber Room tests.

```
vrmarkandroid-vx-x-xxxx-vrma-ipa-android-data-vy-y-yyy.dlc
```

Where `x-x-xxxx` is the application version and `y-y-yyy is` the data package version.

When using the `install_and_run_benchmark_xml.bat` file, the tests are installed first and then the benchmark is run. Thereafter, benchmark runs can be started using `install_and_run_benchmark_xml.bat` or `run_benchmark_xml.bat`, (which skips the installation part).

Note 3: You need to add your license key into the settings XML. For example, the `benchmark_FpsLoggingDemo.xml` and `benchmark_ImageDumpDemo.xml` files need to be edited. There is a comment in both files showing where to add your license key.

Note 4: The application tries to wake the device at the beginning of the test. This may not work on all devices. In such cases, make sure that the device is awake when starting the automation run.

Using automation

Issue the following command to upload an XML file to the device.

```
upload_benchmark_xml.bat benchmark_VrmaAmberRoomPerformance.xml
```

Use `install_and_run_benchmark_xml.bat`, (or `run_benchmark_xml.bat` if the tests are already installed), to start the benchmark run.

After the test has finished you can run `copy_result_zip.bat` to copy the zipped result contents from the device. The zip contains the following files:

- `Arielle.xml`, the main result file with scores, settings, and other info.

- `Result.xml`, a concise file containing only the benchmark scores.
- `Monitoring.csv`, monitoring data from the run, if collecting is enabled.
- `RawMonitoringData.json`, other monitoring data with timestamps.
- `Systeminfo.json`, device identification data.

Note that the external storage file path may vary. Possible values are `/sdcard…` `/storage/sdcard1/` and so on. The values in our examples are common defaults. Please make sure that the external storage path to the VRMark folder is correct for your device before running any tests.

XML INTERFACE

The XML string that is passed with the intent has the following structure:

```
<?xml version="1.0" encoding="UTF-8"?>
<benchmark>
<product>vrma</product>
<test_info>
	<benchmark_tests>
		<benchmark_test
			version="1.2"
			name="test name here"
			test_run_type = "EXPLICIT"/>
	</benchmark_tests>
</test_info>
<settings>
</settings>
</benchmark>
```

The `product` element must have the value `vrma`. The test type and workloads to run are specified in `test_info`. The following values can be used as test names in the `benchmark_test` element.

For Indigo Room tests:

```
VrmaIndigoRoomPerformance
VrmaIndigoRoomSustainabilityQuick
VrmaIndigoRoomSustainabilityHour
VrmaIndigoRoomSustainabilityDay
VrmaIndigoRoomSustainabilityWeek
```

For Purple Room tests:

```
VrmaPurpleRoomPerformance
VrmaPurpleRoomSustainabilityQuick
VrmaPurpleRoomSustainabilityHour
VrmaPurpleRoomSustainabilityDay
VrmaPurpleRoomSustainabilityWeek
```

For Amber Room tests:

```
VrmaAmberRoomPerformance
VrmaAmberRoomSustainabilityQuick
VrmaAmberRoomSustainabilityHour
VrmaAmberRoomSustainabilityDay
VrmaAmberRoomSustainabilityWeek
```

Test run type must be given value `EXPLICIT`.

Configuring a full VRMark benchmark run

A working example can be run with file `benchmark_AmberPerformanceRun.xml`.

```
<?xml version="1.0" encoding="UTF-8"?>
<benchmark>
<product>vrma</product>
<test_info>
	<benchmark_tests>
		<benchmark_test
			version="1.2"
			name="VrmaAmberRoomPerformance"
			test_run_type = "EXPLICIT"/>
	</benchmark_tests>
</test_info>
<settings>
	<!-- <setting> elements here -->
</settings>
</benchmark>
```

Settings

License key

```
<setting>
	<name>license_key</name>
	<value>VRMA-XXX-XXXXX-XXXXX-XXXXX-XXXXX</value>
</setting>
```

Result file path

```
<setting>
	<name>write_benchmark_run_xml_path</name>
	<value>/sdcard/VRMarkAndroid/results/result.zip</value>
</setting>
```

This parameter defaults to an empty string. When this parameter is given a value the workload tries to write the result zip to the file specified by the path. This allows testing of these automation features from the command line using the adb-tool.

USING BENCHMARKLAUNCHERACTIVITY

The workload is exported with the following package and class name:

Package:
`com.ul.benchmarks.vrmark`

Class:
`com.ul.benchmarks.vrmark.ui.BenchmarkLauncherActivity`

Note that the workload activity locks orientation and keeps the screen on.

As intent extra:

The XML configuration must be inserted as extra (`Intent.putExtra`) with the following key:

```
com.futuremark.android.BenchmarkRunXml
```

The following code launches the activity:

```
Intent = new Intent();
ComponentName component = new ComponentName(
        "com.ul.benchmarks.vrmark",
        "com.ul.benchmarks.vrmark.BenchmarkLauncherActivity"
        );
intent.setComponent(component);
String benchmarkXmlString = /* <set>... XML configuration here */;
intent.putExtra(
        "com.futuremark.android.BenchmarkRunXml", benchmarkXmlString);
int requestCode = 1; // This can be anything
startActivityForResult(intent, requestCode);
```

From file:

The *absolute file path* for the XML configuration file must be inserted as extra (`Intent.putExtra`) with the following key:

```
com.futuremark.android.BenchmarkFilePath
```

The following code launches the activity:

```
Intent intent = new Intent();
ComponentName component = new ComponentName(
        "com.ul.benchmarks.vrmark",
        "com.ul.benchmarks.vrmark.BenchmarkLauncherActivity"
        );
intent.setComponent(component);
String benchmarkXmlFilePath = /*
“/sdcard/3DMarkAndroid/benchmark.xml” ... XML configuration file path
here */;
intent.putExtra(
```

```
        "com.futuremark.android.BenchmarkFilePath",
        benchmarkXmlFilePath);
int requestCode = 1; // This can be anything
startActivityForResult(intent, requestCode);
```

GETTING THE RESULT

The result xml can be extracted from the resulting intent with key:

```
com.futuremark.android.BenchmarkRunXml
```

The result xml is basically the same XML that was sent with intent extras, but with results and possibly error messages added. Result XML has the following format:

```
<?xml version="1.0" encoding="UTF-8"?>
<benchmark>
<product>vrma</product>
<application_info>
        ...
</application_info>
<test_info>
        ...
</test_info>
<settings>
        ...
</settings>
<results>
        <result>
                ...
        </result>
        ...
</results>
</benchmark>
```

The result can be extracted in the `onActivityResult` method as in the following example:

```
protected void onActivityResult(int requestCode, int resultCode,
                                Intent data) {
        if (resultCode == RESULT_OK)
        {
                String resultXmlString = data.getStringExtra(
                "com.futuremark.android.BenchmarkRunXml");
        }
}
```

EXAMPLE CONFIGURATION XML

The following XML string can be passed to the intent for running a benchmark with default settings on a device.

```
<?xml version="1.0" encoding="UTF-8"?>
<benchmark>
<product>vrma</product>
<test_info>
	<benchmark_tests>
	<benchmark_test
		version="1.0"
		name="VrmaAmberRoomPerformance"
		test_run_type="EXPLICIT"/>
	</benchmark_tests>
</test_info>
<settings>
	<setting>
		<name>license_key</name>
		<value>XXXX-XXX-XXXXX-XXXXX-XXXXX-XXXXX</value>
	</setting>
	<setting>
		<name>write_benchmark_run_xml_path</name>
		<value>/sdcard/VRMarkAndroid/results/result.zip</value>
	</setting>
	</settings>
</benchmark>
```

RELEASE NOTES

VRMark v1.0.71 – June 28, 2018

- Fixed rendering issue with Mali-T* devices.

VRMark v1.0.69 – June 15, 2018

- Minor bug fixes for improved compatibility.

VRMark v1.0.66 – June 14, 2018

- Minor bug fixes for improved compatibility.

VRMark v1.0.63 – June 14, 2018

- Launch version.

ABOUT UL

UL is an independent, global company that offers a wide range of testing, inspection, auditing, and certification services. With 10,000 people in 40 countries, UL helps customers, purchasers, and policymakers navigate market risk and complexity. UL builds trust in the safety, security, and sustainability of products, organizations and supply chains – enabling smarter choices and better lives. Visit https://www.ul.com/ to find out more.

UL benchmarking software is developed by the Product Supply Chain Intelligence division. We enable global product compliance, innovation and promotion throughout the supply chain with our intelligent software and services backed by world-class scientific and technical expertise. Please visit https://psi.ul.com/ to find out more.

UL benchmarks help people measure, understand and manage computer hardware performance. Our talented team creates the industry's most trusted and widely used performance tests for desktop computers, notebooks, tablets, smartphones, and VR systems.

We work in cooperation with leading technology companies to develop industry-standard benchmarks that are relevant, accurate, and impartial. As a result, our benchmarks are widely used by the press. UL maintains the world's largest and most comprehensive hardware performance database, using the results submitted by millions of users to drive innovative online solutions designed to help people make informed purchasing decisions.

Our benchmarks are developed in Finland just outside the capital Helsinki. We also have a performance lab and sales office in Silicon Valley and sales representatives in People’s Republic of China and Taiwan, ROC.

Press	UL.BenchmarkPress@ul.com
Sales	UL.BenchmarkSales@ul.com
Support	UL.BenchmarkSupport@ul.com