Vulkanised 2025

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Current state of Lavapipe: Mesa's software renderer for Vulkan

Lucas Fryzek, Igalia

Introduction

- Working on Graphics drivers since ~2016
- Graphics software developer at Igalia since 2023
  - Contributing to Lavapipe for the last year
  - Working on platform integration on Android and performance improvements for WSI

Introduction

- Why present Lavapipe?
- Last year's Vulkanised had a big discussion on a "Reference Vulkan Driver"
- Lavapipe is not an official reference but it is a conformant Vulkan driver you can run just about anywhere

What is Lavapipe

- Currently conformant to Vulkan 1.3
- Exposes all core Vulkan 1.4 extensions
  - Has not been submitted for Conformance yet

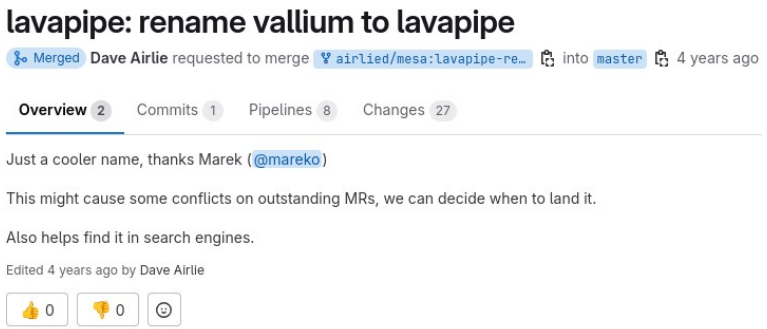
Software in the Public Interest, Inc. 2022-07-19 Vulkan_1_3	696
Linux Mesa lavapipe 22.1.2	CTS Version: 1.3.1.1 Linux 5.17.7 AMD Ryzen 7 1800X Eight-Core Processor X11

What is Lavapipe?

- An Open Source Vulkan software rasterizer
- Uses LLVM to compile shaders into native code
- Part of the Mesa driver ecosystem

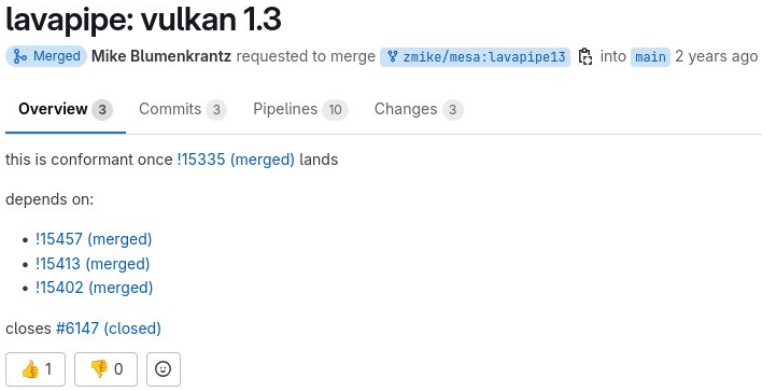
Brief History of Lavapipe

- Started in 2020 by Dave Airlie
  - Started as “Vallium” quickly renamed to “Lavapipe”
- Originally could only run basic Vulkan samples



Brief History of Lavapipe

- In 2022 Vulkan 1.2 conformance and then 1.3 conformance
- In 2024 Lavapipe exposed all promoted extensions in Vulkan 1.4
- Today can run most Vulkan applications
  - Although slower than a GPU would



lavapipe: vulkan 1.3

Merged **Mike Blumenkrantz** requested to merge `zmike/mesa:lavapipe13` into `main` 2 years ago

Overview 3 | Commits 3 | Pipelines 10 | Changes 3

this is conformant once !15335 (merged) lands

depends on:

- !15457 (merged)
- !15413 (merged)
- !15402 (merged)

closes #6147 (closed)

👍 1 👎 0

Why do I need a SW renderer?

- Fallback for when GPU is not available or missing extensions
- On virtual machines (e.g. cloud devices) that don't have access to a GPU
- Always accessible platform to test graphics code against

Why use Lavapipe

- Test the latest and greatest Vulkan functionality before hardware vendors have had a chance to implement them
  - ➔ Lavapipe was used extensively for developing VK CTS for VK_EXT_device_generated_commands

Why use Lavapipe

- Test graphics code on virtual machines
  - ➔ For example, running Vulkan code inside CI where runners don’t have access to a GPU

Why use Lavapipe

- Always have a fallback driver for application that need more modern HW features
- Always have a fallback driver to test application vs driver issues

Current state of Lavapipe

- All extension promoted to core
- in Vulkan 1.4 are supported
- Supports advanced extensions
- VK_KHR_ray_query
- VK_EXT_device_generated_commands
- VK_KHR_ray_tracing_pipeline
- VK_EXT_shader_object
- VK_EXT_mesh_shader

Comparing to other SW Rasterizers

- Only real alternative is SwiftShader
- Swiftshader is also Vulkan 1.3 conformant
  - Missing half of the extensions for Vulkan 1.4
- Lavapipe is 42% faster in vkmark
  - Testing on Ryzen 6850u with 32GB of RAM

How can I use Lavapipe?

- Runs on
  - Windows
  - Mac
  - Linux
  - Android
- Three options
- Official binaries
- Unofficial binaries
- Build from source
- https://gitlab.freedesktop.org/mesa/mesa

How can I use Lavapipe?

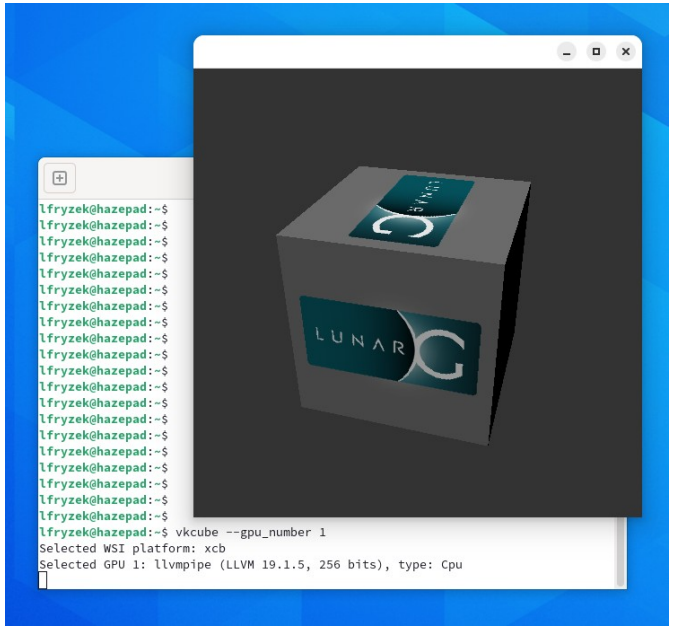
- Can use Vulkan Loader's environment variables to pick Lavapipe's ICD file
  - Set VK_DRIVER_FILES
  - https://github.com/KhronosGroup/Vulkan-Loader/blob/main/docs/LoaderInterfaceArchitecture.md#table-of-debug-environment-variables

Lavapipe - Windows

- Unofficial binaries available
  - https://github.com/pal1000/mesa-dist-win
- Build from source
  - https://docs.mesa3d.org/meson.html#windows-specific-instructions

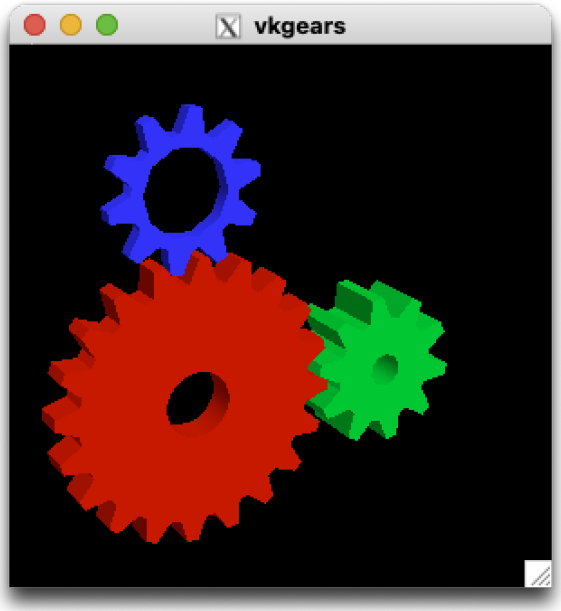
Lavapipe – Linux

- Officially included by default in most Linux distros
- Build from source
- https://docs.mesa3d.org/meson.html#unix-like-oses



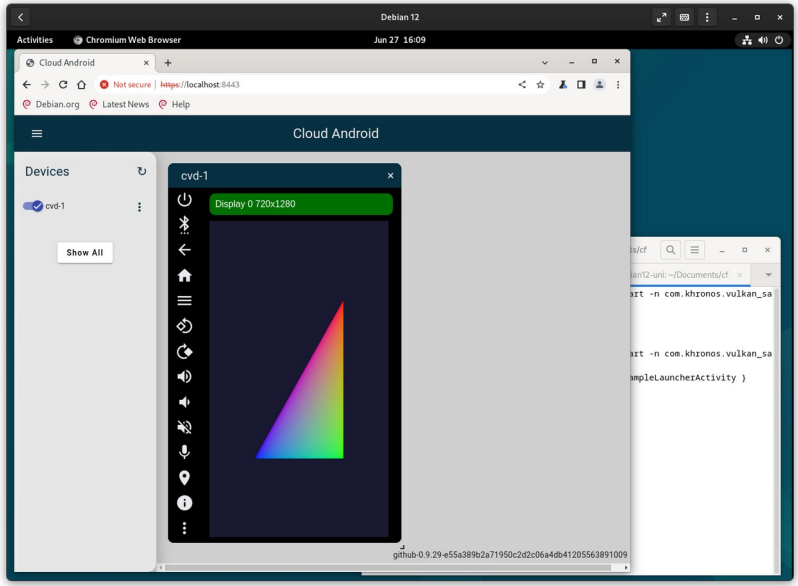
Lavapipe – Mac

- Build from source
- https://docs.mesa3d.org/meson.html#unix-like-oses



Lavapipe - Android

- Build from source out of the android source tree
  - https://docs.mesa3d.org/drivers/llvmpipe.html#building-for-android
  - https://docs.mesa3d.org/android.html#adding-out-of-tree-drivers-to-android-os-image

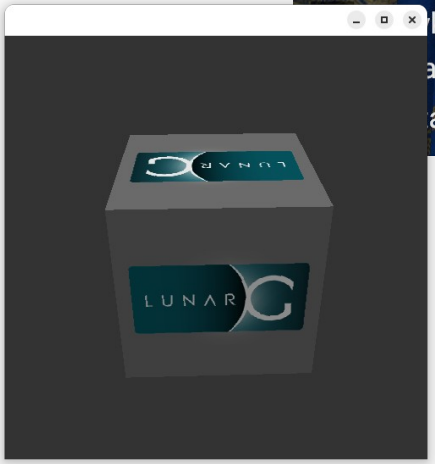


Want to help out?

- File an issue on mesa's gitlab
  - https://gitlab.freedesktop.org/mesa/mesa/-/issues/new
- Send a message to #dri-devel on the OFTC IRC server
- Contact the mesa-users or mesa-dev mailing list
  - https://docs.mesa3d.org/lists.html

Lavapipe Examples


Render Passes
Fragment Cycles: not available
External Read Bytes: not available
External Write Bytes: not available
GPU: llvmpipe (LLVM 19.1.5, 256 bits)
kCmdClearAttachments (color)
achment load operation:
Load
Clear
Don't care
achment store operation:
Store
Don't care


LUNAR
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QUAKE
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Thanks!

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