Overview of the Open Source Vulkan Driver for Raspberry Pi 4

Alejandro Piñeiro Iglesias <apinheiro@igalia.com>

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Development Story

Development Story

- Driver code name: V3DV.
- Development started in a public fork of Mesa.
- Leverages Mesa Vulkan WSI.
- Expands existing V3D NIR compiler.
- Same kernel interface as V3D.

Development Story

- [Nov 19] Development start.
- [Jan 20] Triangle demo.
- [May 20] Bunch of Sascha Willem’s demos running.
- [Jun 20] Moved development to open repositories.
- [Jul 20] All Quake games working.
- [Aug 20] Minimal Vulkan 1.0 implementation.

Development Story

- [Oct 20] Moved development to Mesa upstream
- [Nov 20] Improved Zink interoperability
- [Nov 20] Vulkan 1.0 conformant
- [Dec 20] Tested on 64-bit, working on performance

Development Story

- Initial early milestone to render on hardware.
- Vulkan CTS to help iterative feature development.
  - Requires minimal functionality in the driver first.
  - Helped improve CTS coverage.

Development Story

- Growing subset of CTS for regression testing.
  - Parallel deqp runner for faster execution.
  - Currently ~10K tests (~10% of CTS pass list).
- Weekly rebases and full CTS runs.
- Assert everywhere philosophy.
- Progress updates via blog posts.

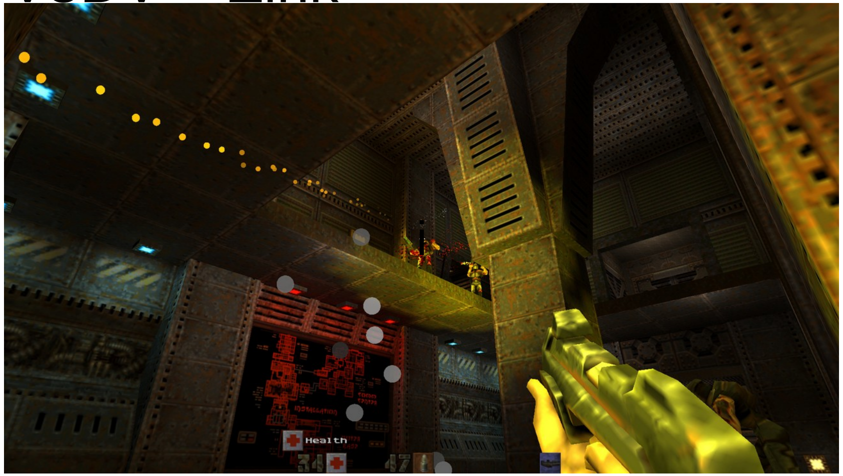
Current State

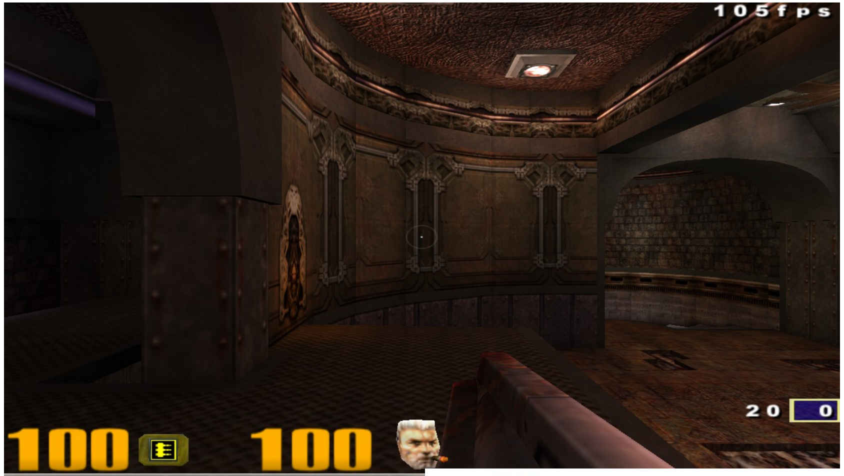
Current State

- Vulkan 1.0 mandatory feature set complete.
  - A bunch of optional features too.
  - Many optional features and extensions missing.
- We got 1.0 conformance on November
  - Passing ~110K tests (~675k skipped)
  - We keep doing regular full CTS runs

Current State

- VkQuake 1-3 & OpenArena.
- PPSSPP (Vulkan PSP emulator).
- V3DV + Zink





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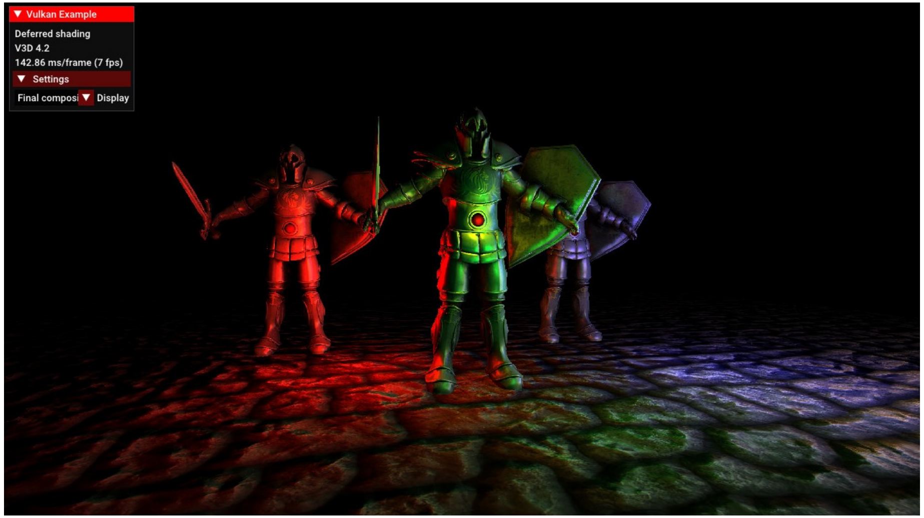
Current State

- Many demos from Sascha Willems working:



▼ Vulkan Example

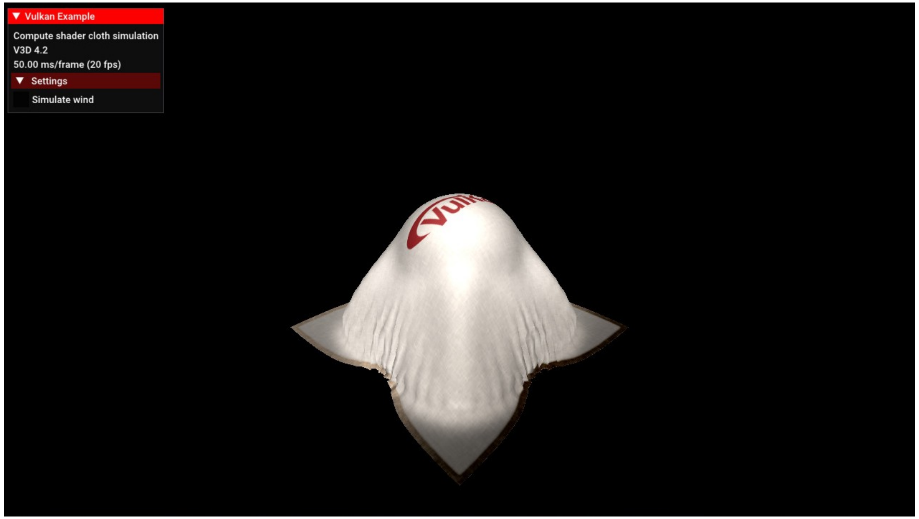
Deferred shading

V3D 4.2

142.86 ms/frame (7 fps)

▼ Settings

Final composi ▼ Display



▼ Vulkan Example

Compute shader cloth simulation

V3D 4.2

50.00 ms/frame (20 fps)

▼ Settings

□ Simulate wind

Current State

- Not much performance work yet.
  - Mostly for the Quake games.
  - VkQuake3 much faster than its GL1 renderer.

Current State

- Aware of some slow paths in the driver.
  - Particularly for some cases of transfer ops.
  - Possibly underused TFU unit.

Implementation Challenges

Implementation Challenges

- Vulkan expects everything to execute in GPU.
  - Not quite possible for us in a few selected cases.
  - Caused some implementation churn.
  - Incurs in additional coordination (flushes).

Implementation Challenges

- Linear display pipeline in Raspberry Pi 4
  - V3D cannot sample from linear images.
  - For now, we don’t support sampling on swapchains.
  - We should be able to sample in windowed mode when running inside a compositor… worth it?

Implementation Challenges

- Mesa WSI implementation not optimal for us.
  - Optimal path requires PCI GPU and VK_EXT_pci_bus_info.
  - Raspberry Pi display device is not a PCI device.
    - We just want to check that DRI3 device matches.
  - RFC MR with a solution proposed.

Future Plans

Future Plans

- Short term:

More real world testing!!

Future Plans

- Short/Medium term:
  - Explore better TFU unit usage.
  - Better WSI platform support.
  - Optimal implementation of input attachments.
  - Optional features & extensions
  - Assess driver performance and figure out ways to improve it

Future Plans

- Long term:
  - Maybe Vulkan 1.1?
  - Improve code reuse with GLES driver.
  - Maybe port some features to GLES driver:
    - Hardware multisample resolve.
    - Sample rate shading.
    - Robust buffer access.

Contributing

Contributing

- Stable context to enable external contributors.
- V3D 4.2 docs not available to general public.
  - GLES 3.1 open source driver can make up for this.
- Lots of FIXMEs in the source code.
- Many optional features pending.
- Testing and performance feedback.

Contributing

- Resources:
  - #videocore @ freenode
  - mesa-dev mailing list
  - Gitlab issues

Special Thanks

- Mesa community, for NIR, SPIR-V translator, WSI bits, etc.
- Existing Mesa Vulkan driver developers.
- Eric Anholt
- Dave Emett

Q&A

We are hiring: www.igalia.com/jobs