MoltenVK and Vulkan Portability Update

Bill Hollings, The Brenwill Workshop Ltd.
Portable access to layered Vulkan functionality
Vulkan Portability

Portable access to layered Vulkan functionality
https://github.com/KhronosGroup/Vulkan-Portability

Encourage layered Vulkan functionality implementations
Enabling Vulkan applications on platforms without native drivers

Khronos Portability Extension
Portable queries for functionality not available through Vulkan layering

Vulkan Conformance Test Development
Handle partial functionality to enable Vulkan Portability conformance
What is present must work!

Enhanced Vulkan SDK, Layers and Tools
Validation and Profile Layers flag or simulate queries for non-present features
# Open-Source Layering Projects

## Fighting Platform Fragmentation

<table>
<thead>
<tr>
<th>Layers Over</th>
<th>Vulkan</th>
<th>OpenGL</th>
<th>OpenCL</th>
<th>OpenGL ES</th>
<th>DX12</th>
<th>DX9-11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vulkan</td>
<td></td>
<td>Zink</td>
<td>clspv + clvk</td>
<td>Angle</td>
<td>vkd3d-Proton vkd3d</td>
<td>DXVK WineD3D</td>
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<tr>
<td>OpenGL</td>
<td>Ashes</td>
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<td>Angle</td>
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<td>WineD3D</td>
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<td>DX12</td>
<td>Microsoft Dozen</td>
<td>Microsoft ‘GLOn12’</td>
<td>Microsoft ‘CLOn12’</td>
<td>Angle</td>
<td>Microsoft D3D11On12</td>
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<td></td>
<td>Angle</td>
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<tr>
<td>Metal</td>
<td>MoltenVK</td>
<td>clspv + SPIRV-Cross?</td>
<td>MoltenGL</td>
<td>Angle</td>
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</tbody>
</table>

**Vulkan as porting target for multiple APIs**

**ROWS:** Bring more APIs to Platforms

**COLUMNS:** Making APIs available across platforms

**Vulkan functionality available everywhere**
Current Vulkan Portability Activities

- MoltenVK Vulkan 1.0 CTS: 195,805 pass / 285 fail (0.15%)

- Reach zero CTS failures for Vulkan 1.0
  - VK_KHR_portability_subset_metal (replaces VK_KHR_portability_subset)
  - Widen CTS thresholds
  - CTS Waivers for Metal bugs
  - MoltenVK/SPIRV-Cross fixes

- Finalize VK_KHR_portability_subset_metal extension
  - Focus on extension per platform, with Metal first.
  - Deprecate general provisional multi-platform VK_KHR_portability_subset

- Vulkan samples available on iOS and macOS
  - Using Loader and conformant Profiles Layers wherever possible
MoltenVK
Vulkan over Metal
Apple platform interest from 30+% of devs

Vulkan Runtime Platforms
(LunarG 2023 Developer Survey)

macOS Vulkan SDK about 5,800 downloads per week.
Currently growing faster than other platforms.

Vulkan Development Platforms
(LunarG 2023 Developer Survey)
Who’s Using MoltenVK?

- **Games shipping with MoltenVK:**
  - DOTA 2
  - Metro Exodus
  - Final Fantasy XIV
  - Dark Souls: Remastered
  - Dark Souls III
  - DOTA Underlords
  - AeroFly Flight Simulator 2
  - Path of Exile
  - Raft
  - The Elder Scrolls Online
  - Celeste
  - Transport Fever 2
  - Shadow Warrior 2
  - Streets of Rage 4
  - Jupiter Hell
  - Wreckfest
  - Victoria 3
  - Artifact
  - GZDOOM
  - vkQuake & vkQuake2

- **Games runnable by users via Crossover and MoltenVK:**
  - Halo: Combat Evolved
  - God of War (2018)
  - Grand Theft Auto V
  - World Of Tanks
  - Forsaken Remastered
  - Elder Scrolls V Skyrim: SE
  - Guild Wars 2
  - Battlefield 1
  - Battlefront II
  - Age of Empires II: Definitive Edition
  - Witcher 3

- **Applications shipping with MoltenVK:**
  - Autodesk Fusion 360
  - Autodesk Flame
  - Ultra Engine
  - Diligent Engine
  - Blender Vulkan (PoC)
  - Defold
  - Clausewitz Engine (Paradox)
  - ncnn

- **Engines using MoltenVK:**
  - Google Filament
  - Facebook IGL
  - LightweightVK
  - vkQuake & vkQuake2

- **Platform emulators using MoltenVK:**
  - VKD3D (Direct3D 12)
  - DXVK (Direct3D 9/10/11)
  - Google Android Emulator
  - Dolphin (Wii & GameCube)
  - Cemu (Wii U)
  - Ryujinx (Switch)
  - Citra (Nintendo 3DS)
  - RPCS3 (PS3)
  - PCSX2 (PS2)

Testing 15 games with MoltenVK support
https://youtu.be/xDGQcjqpYql
MoltenVK Status

- **Supports Vulkan 1.2 + extensions**
  - Five Vulkan extensions remaining

- **Developers can use Vulkan SDK on macOS**
  - Deploy onto macOS, iOS, & tvOS

- **Coming soon in priority order**
  - Optional build support for private Metal APIs (eg. Wide lines)
    - Not available for App Store distribution
  - VK_KHR_maintenance4
  - CTS failure reduction for Vulkan 1.0 Portability conformance
  - Improved functionality/performance for bindless resources via Metal 3 argument buffers
  - VK_EXT_descriptor_buffer
  - Vulkan 1.3 (5 extensions left)
    - Transform Feedback
    - Vulkan Acceleration Structures (initial ray tracing)
    - Faster pipeline caching with Metal Binary Archives
    - CTS failure reduction for Vulkan 1.2 Portability conformance

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<tr>
<th>Extension</th>
<th>MoltenVK Support</th>
<th>Status Notes</th>
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<tr>
<td>VK_KHR_copy_commands2</td>
<td>✔</td>
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<tr>
<td>VK_KHR_dynamic_rendering</td>
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<tr>
<td>VK_KHR_format_feature_flags2</td>
<td>✔</td>
<td>Added [PR2709]</td>
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<tr>
<td>VK_KHR_maintenance4</td>
<td>✔</td>
<td>In Dev [PR2196]</td>
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<tr>
<td>VK_KHR_shader_integer_dot_product</td>
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<td>Added [PR2199]</td>
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<tr>
<td>VK_KHR_shader_non_semantic_info</td>
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<td>VK_KHR_shader_teminate_invocation</td>
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<td>VK_KHR_synchronization</td>
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<td>Added [PR2927]</td>
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MoltenVK Resourcing

- Open-source project with a small team

- Targeted funding from MoltenVK users
  - Improve MoltenVK functionality and conformance
  - Better support for Android Emulator & other apps
  - Exploring ray-tracing funding

- Smaller contributions from other users

- Additional funding & contributions always welcome!