Xen based GPU virtualization –
dGPU prime

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Background of dGPU prime

• Intention
  • OpenGL and Vulkan: dGPU prime allows an integrated GPU (iGPU) to display output data rendered by a discrete GPU (dGPU)

• Background
  • Virgl and Venus
    • Not support DMA
    • Not implement import/export
  • Xen VMs
    • Low performance: sync data depend on memcpy from guest to host via IOV

• Proposal
  • Implement dGPU prime on virgl and venus
dGPU Prime on Xen GPU Virtualization -- overall

- **Platform**
  - Ubuntu 22.04
  - XEN hypervisor + QEMU

- **GPU and driver**
  - Integrated GPU (iGPU) + Virtio-GPU driver
  - Passsthrough discrete GPU (dGPU) + AMDGPU driver
dGPU Prime of Virgl(OpenGL)

- Create display buffer
  - Guest mesa side: send command to create host resource
  - Host virglrenderer side: create texture

- Import display buffer as linear buffer/blit dst
  - Get display buffer handle
  - Create linear buffer from display buffer handle

- Sync rendered data
  - Send command to copy data from guest IOV to host resource
dGPU Prime of Venus(Vulkan)

• Create display buffer
  • Guest mesa side: GBM create display buffer → send command to create host resource
  • Host virglrenderer side: import host resource as pipe resource → create texture

• Import display buffer as linear buffer (blit dst)
  • Import gbm_bo as foreign mem
  • Bind linear buffer of swapchain with foreign mem

• Sync rendered data
  • Send command to copy data from guest IOV to host resource
Improvement of dGPU prime

- **Query stride**
  - Existing logic: align virgl resource stride to 256
  - Our design: send command to host to query buffer stride using GBM

- **Improve performance**
  - Existing logic: send command every time swap buffer → Low benchmark scores
  - Our design
    - Create blob resource for linear buffer
    - Map host blob resource to guest → Guest mesa blit data to host pipe resource directly
Improvement of dGPU prime

- Native context: virtio-GPU + passthrough GPU

- Two virtio-GPU
### dGPU prime Comparison between virgl and virgl + blob

<table>
<thead>
<tr>
<th>Test Cases (Unit: FPS)</th>
<th>Histogram</th>
<th>Bare-Metal - Native (RadeonSi)</th>
<th>DOMU - virgl</th>
<th>DOMU – Virgl + blob</th>
</tr>
</thead>
<tbody>
<tr>
<td>glMark2</td>
<td><img src="image" alt="glMark2 Histogram" /></td>
<td>420</td>
<td>213</td>
<td>416 (195.31%)</td>
</tr>
<tr>
<td>Madmax</td>
<td><img src="image" alt="Madmax Histogram" /></td>
<td>106.2</td>
<td>78.2</td>
<td>94.9 (121.36%)</td>
</tr>
<tr>
<td>Unigine Valley</td>
<td><img src="image" alt="Unigine Valley Histogram" /></td>
<td>100.5</td>
<td>38.3</td>
<td>40.1 (104.70%)</td>
</tr>
<tr>
<td>GFXBench (gl_Manhattan)</td>
<td><img src="image" alt="GFXBench Histogram" /></td>
<td>383.2</td>
<td>55.8</td>
<td>128.4 (230.11%)</td>
</tr>
</tbody>
</table>
# dGPU prime Comparison between venus and venus + blob

<table>
<thead>
<tr>
<th>Test Cases (Unit: FPS)</th>
<th>Histogram</th>
<th>Bare-Metal - Native (Radv)</th>
<th>DOMU - Venus</th>
<th>DOMU – Venus + blob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rise Of The Tomb Raider</td>
<td><img src="image1" alt="Histogram" /></td>
<td>119.18</td>
<td>48.18</td>
<td>91.54 (190.0%)</td>
</tr>
<tr>
<td>3DMark Wildlife Extreme</td>
<td><img src="image2" alt="Histogram" /></td>
<td>82.47</td>
<td>22.4</td>
<td>63.5 (283.4%)</td>
</tr>
<tr>
<td>GFXBench (vulkan_5_high)</td>
<td><img src="image3" alt="Histogram" /></td>
<td>273.4</td>
<td>49.2</td>
<td>139 (282.5%)</td>
</tr>
<tr>
<td>GFXBench (vulkan_5_normal)</td>
<td><img src="image4" alt="Histogram" /></td>
<td>387.63</td>
<td>153.4</td>
<td>174.3 (113.6%)</td>
</tr>
</tbody>
</table>
References

- Repositories
  - Virglrenderer - https://gitlab.freedesktop.org/Julia/virglrenderer/-/commits/upstream-dGPU_prime
  - Mesa - https://gitlab.freedesktop.org/Julia/mesa/-/commits/upstream-dGPU_prime_virgl

- Upstream is in progress
  - Mesa - https://gitlab.freedesktop.org/mesa/mesa/-/merge_requests/23896
  - Virglrenderer - https://gitlab.freedesktop.org/virgl/virglrenderer/-/merge_requests/1268
Thanks

- Bob and Daniel from Collabora (GBM bo create)
- Ray from AMD(Enable blob memory on XEN)
- Pierre Eric from AMD(Native context for amdgpu)
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