Tauray: Supplementary Material

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RENDERER COMPARISON

Table 1 contains a survey of hardware-accelerated real time ray tracing renderers. The field is starting to be quite large, and it is quickly becoming extremely difficult to map out all of the renderers in existence, so this survey may not be exhaustive. A few toy/tutorial renderers with extremely limited functionality (such as the NVIDIA Vulkan Ray Tracing Tutorial [Lefrançois et al. 2022]) were skipped from the comparison. We also skipped the renderers that are primarily offline but offer a low-resolution interactive preview, such as Blender's Cycles [Blender Foundation 2021] and AMD Radeon ProRender [Advanced Micro Devices, Inc 2022].

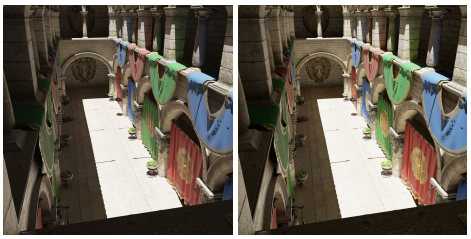
The information in Table 1 was primarily gathered by reading the documentation for each renderer. If there was no documented information for a specific category, we directly observed the source code in the case of open-source renderers. For closed-source software, we have noted uncertain information as such in the table. Table cells with notable caveats are marked in pale green.

IMAGE QUALITY COMPARISON

4096 spp reference images of the scenes rendered in each of the compared renderers are shown in Figures 1–3. Note that while the timing is reported for 1920×1080, the output images in the figures are at a resolution of 1024×1024 for layout purposes.

Figure 2 shows that Blender handles alpha blended transparency somewhat differently than Tauray and Falcor. This is reflected in its UI, where "transparent max bounces" can be adjusted separately from all other bounce parameters. Tauray and Falcor handle all these alpha layers without the black artifacts present in Blender. The major differences in this scene are limited to the alpha blending. We were unable to test this scene with Lighthouse 2 due to it running out of memory during the loading of this scene on our test computer.

Figure 3 has some differences in brightness, which may be related to differences in material models. It also appears that Lighthouse 2 interprets textures differently than the other three renderers, because the textured floor and painting appear "washed out". Another point of interest is the reflective caustic on the left wall that Tauray and Falcor reproduce, but Lighthouse 2 and Blender do not. Lighthouse 2 adjusts material to be more diffuse after one bounce. As for Blender, its "Filter Glossy" option, which is on by default, is responsible for hiding this effect. Likely due to differences with this specific effect, Tauray and Falcor also have a roughly equivalent amount of "firefly" artifacts, which are not present either in Lighthouse 2 or Blender.



(a) Tauray (32.5 s) **(b) Falcor (69.7 s)**

(c) Lighthouse 2 (38.9 s) **(d) Blender (217 s)**

Figure 1: 4096 spp reference images of the Sponza test scene and their single-GPU rendering speed at 1920×1080.

(a) Tauray (152 s) **(b) Falcor (347 s)** **(c) Blender (601 s)**

Figure 2: 4096 spp reference images of the Emerald Square test scene and their single-GPU rendering speed at 1920×1080. Lighthouse 2 ran out of memory with this scene.

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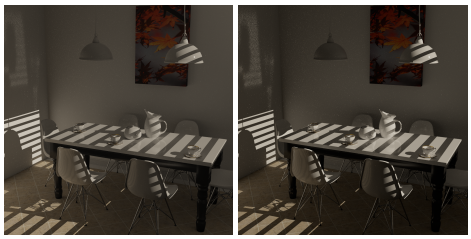
Table 1: Feature comparison of real-time ray tracing renderers which support hardware acceleration.

	Any VR support	OpenXR support	Real-time light field output	Multi-GPU support	Distributed rendering	Denoiser support for RT	Vulkan API support	Open source	Path tracing
Tauray	Yes	Yes	Yes	Yes	No, planned	Yes	Yes	Yes	Yes
Chaos Vantage [Chaos Software EOOD. 2020]	No	No	No	Yes	Appears to support, batching is advertised	Yes	No, appears to use DXR	No	Not documented as such
Diligent Engine [Diligent Graphics 2022]	No, but third-party implementation exists [Ludwig 2021]	No, but third-party implementation exists [Ludwig 2021]	No	No	No	No	Yes	Yes	No
Falcor [Kallweit et al. 2022]	Supports in older versions, missing from newer releases	No	No	No	No	Yes	Yes	Yes	Yes
G3D [McGuire et al. 2017]	Yes	No	Not directly, but supports multiple views in one scene	Implicitly with OpenGL (SLI) and OptiX 6.5	No, but simple support for remote rendering	Yes, but only basic bilateral & temporal filters	Only through OpenGL interop	Yes	Yes, but not real-time
Kajiya [Embark Studios 2022]	No	No	No	No	No	Yes, but not for PT	Yes	Yes	Yes
Lighthouse 2 [Bikker 2021]	No	No	No	Yes, but seems to run slower than one GPU	No	Yes	Yes	Yes	Yes
Malia [Dufay et al. 2021]	No	No	Not directly, but supports multiple views in one scene	Possibly with IRAY & OptiX backends	Possibly with IRAY backend	No	No	Yes	Yes
Nabla [Devsh Graphics Programming Sp. z O.O. 2022]	No	No	Not directly, but supports multiple views in one scene	No	No	Yes	Yes	Yes	Yes
NVIDIA IRAY [NVIDIA Corporation 2020]	Yes	No	Yes (Hogel Rendering)	Yes	Yes	Yes	No	No	Yes
PBRVulkan [Zielonka 2021]	No	No	No	No	No	Yes, basic A-Trous	Yes	Yes	Yes
Quartz [Siejak 2019]	No	No	No	No	No	No	Yes	Yes	Yes
Unity 2022.1 HDRP [Unity Technologies 2022b]	Yes	Yes	No, but third-party plugin exists [Looking Glass Factory, Inc. 2022]	No, but third-party plugin exists [MiddleVR 2022]	No, but third-party plugin exists [MiddleVR 2022]	Yes for RT effects, coming for PT soon [Unity Technologies 2022a]	Yes	No, partially available for reference	Yes
Unreal Engine 5 [Epic Games, Inc. 2022]	Yes	Yes	No, but third-party plugin exists [Looking Glass Factory, Inc. 2022]	Not for real-time RT	Not for real-time RT	Yes	Only for raster, RT requires DirectX 12	No, source available for licensees and subscribers	Yes
Wicked Engine [János 2022]	No	No	No	No	No	Yes	Yes	Yes	Yes



(a) Tauray (15.6 s) **(b) Falcor (47.7 s)**

(c) Lighthouse 2 (15.6 s) **(d) Blender (223 s)**

Figure 3: 4096 spp reference images of the Breakfast Room test scene and their single-GPU rendering speed at 1920×1080.

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