Naga to DXIL

Obed Lee

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1 Abstract

Firefox's implementation of the WebGPU W3C standard uses Naga, a Rust crate, to translate WGSL into backend shading languages. One opensource implementation, wgpu, currently follows this path on Windows:

$$WGSL \rightarrow Naga \rightarrow HLSL \rightarrow DXC \rightarrow DXIL \rightarrow Direct3D12.$$

DXIL is a derivative of LLVM IR and already structurally close to Naga's IR. The transformations that DXC must apply to generate DXIL, such as scalarizing vector and matrix types, are not complex; thus, producing DXIL directly from Naga IR is both feasible and attractive.

2 Objective

Remove the HLSL $\rightarrow$ DXIL hop by generating valid DXIL modules straight from Naga.

3 Methodology

1. Map Naga IR constructs to DXIL opcodes, metadata, and scalarized forms.

2. Implement a new DXIL backend in Naga.

3. Lower operations to `dx.op.*` intrinsics.

4. Validate the output using the open-sourced DXIL validator.

5. Fall back to DXC if validation fails, recording discrepancies.

6. Compile the existing wgpu example suite, measuring compiler time and GPU frame times.

4 Expected Result

- First open-source DXIL generator outside of DXC.

- Quantitatively measure compile time and runtime to assess the benefits of directly producing DXIL from Naga IR.

5 Resources and Advisors

- Hardware: Department's GPUs

- Software: Rust toolchain, reference DXC sources

- Advisors: Prof. Bart, Jim Blandy

References

[1] gfx-rs. 2025. *wgpu.* `https://github.com/gfx-rs/wgpu`. Accessed July 3, 2025.

[2] gfx-rs. 2025. *Naga.* `https://github.com/gfx-rs/wgpu/tree/trunk/naga`. Accessed July 3, 2025.

[3] Microsoft. 2024. *Open-sourcing the DXIL validator hash.* `https://devblogs.microsoft.com/directx/open-sourcing-dxil-validator-hash/`. Accessed July 3, 2025.

[4] LLVM Project. 2025. *LLVM Project.* `https://llvm.org`. Accessed July 3, 2025.