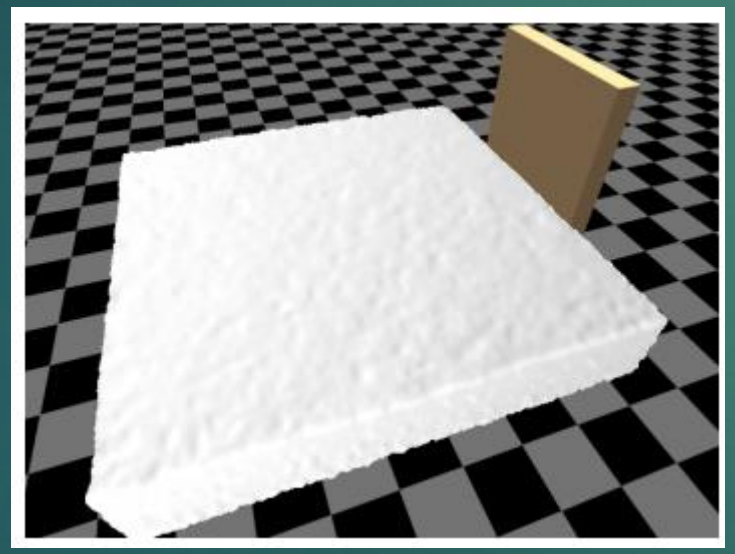
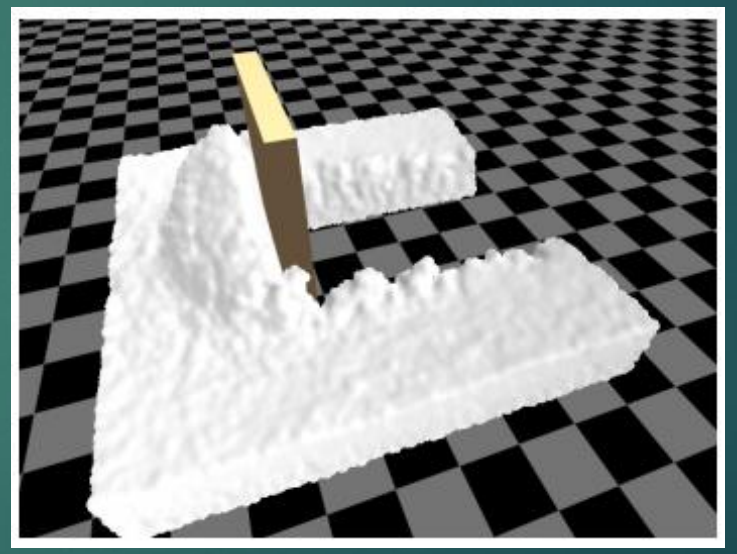
Real-time Particle-based Snow Simulation with Vulkan

Milestone 1





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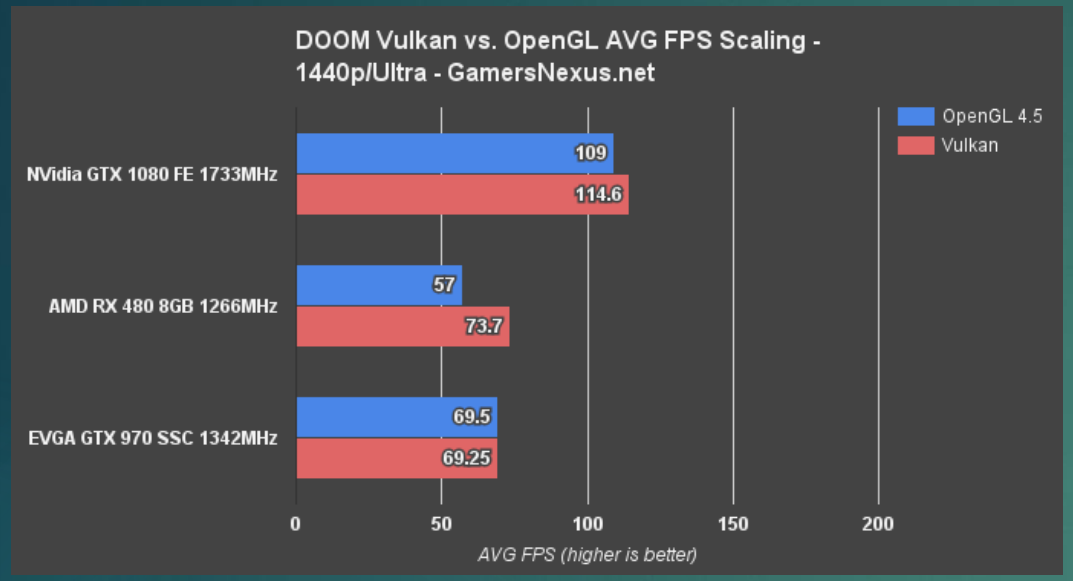
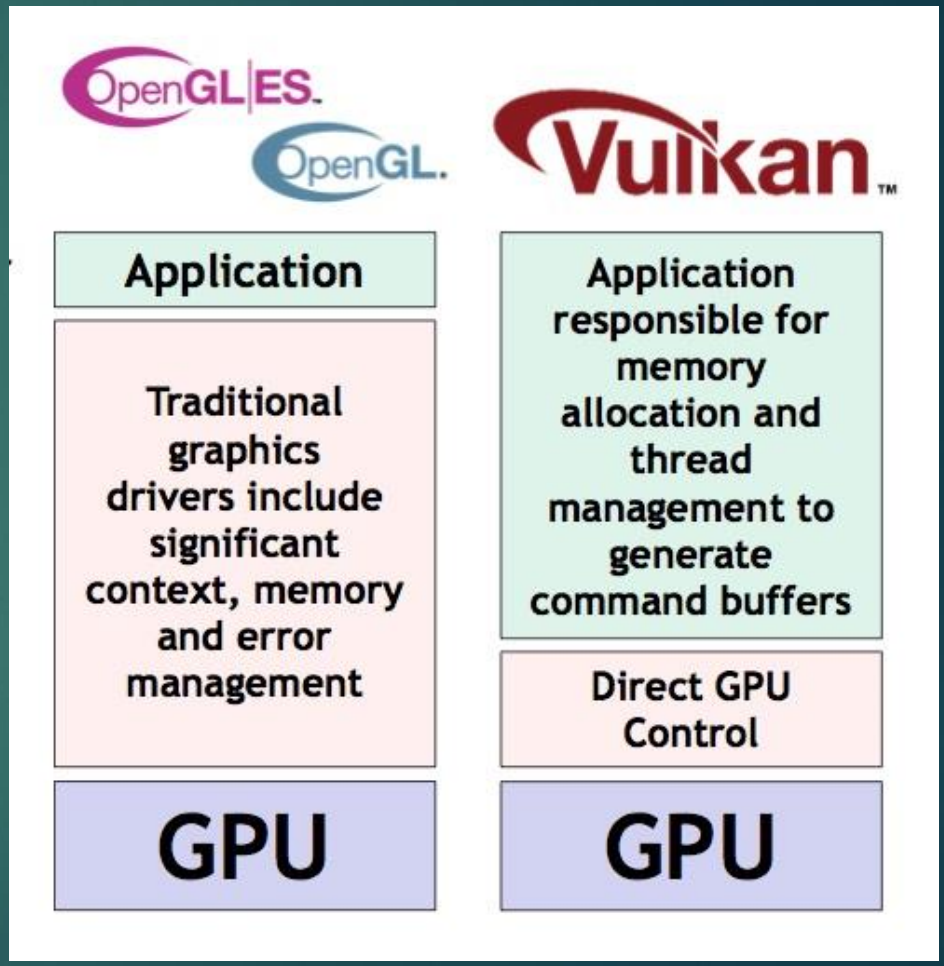
Why Vulkan

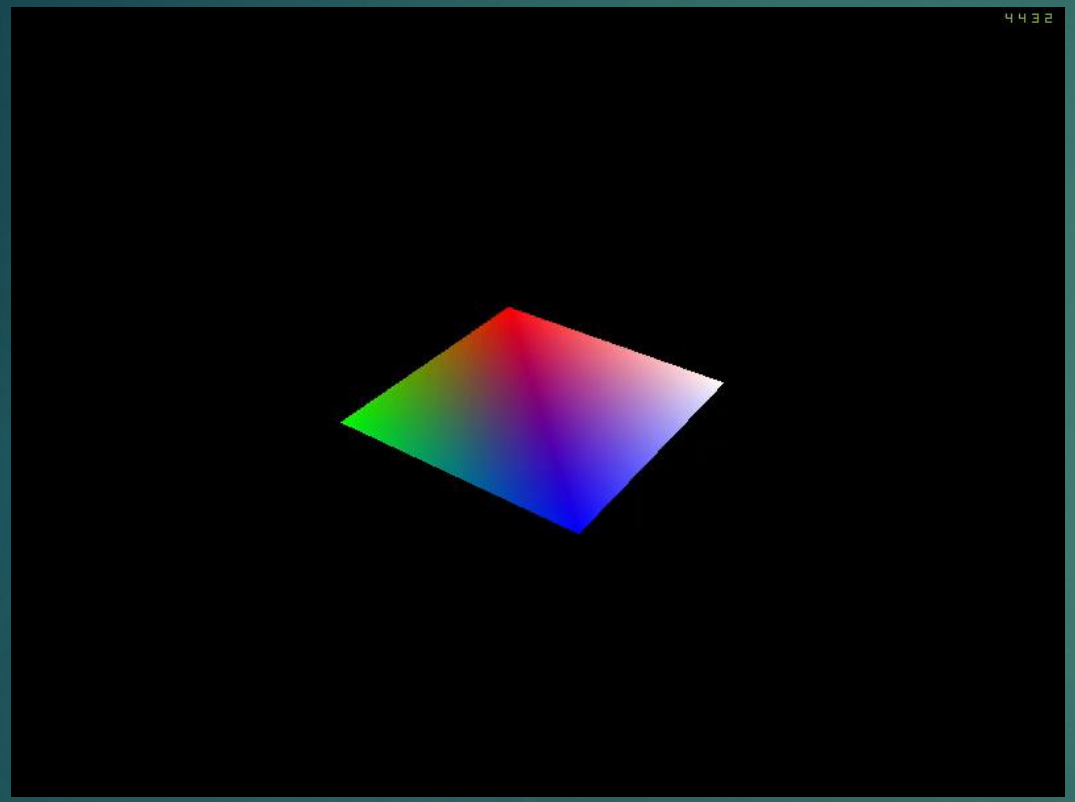


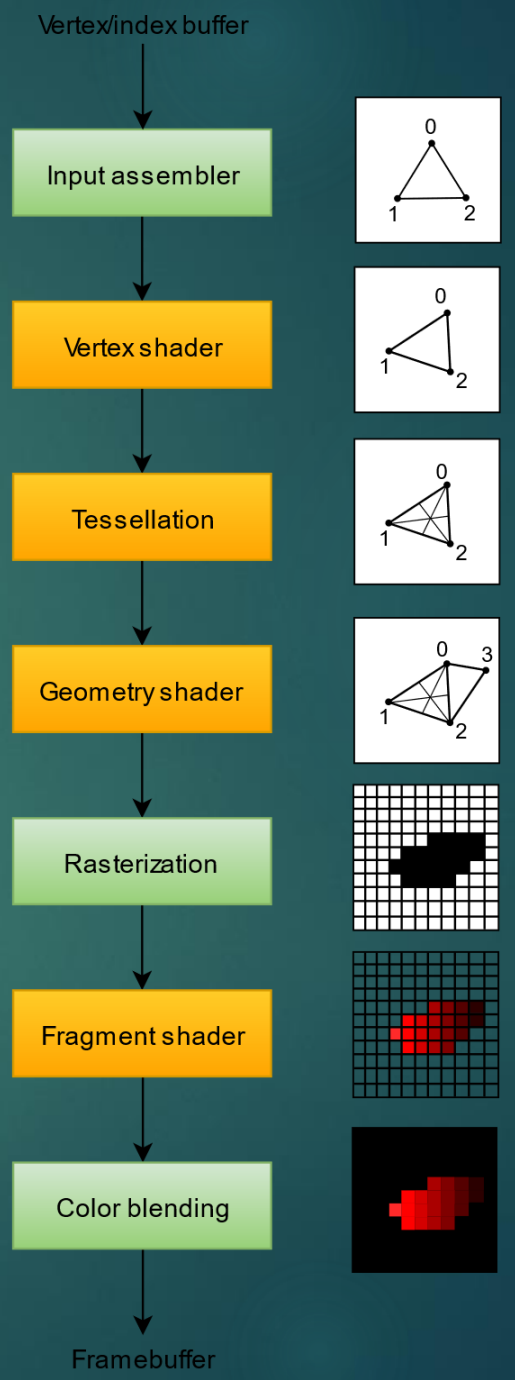
1. Simpler drivers for low-overhead efficiency and cross vendor portability.
2. Layered architecture so validation and debug layers can be unloaded when not needed.
3. Unified API for mobile, desktop, console and embedded platforms.



Reference : https://www.extremetech.com/gaming/212025-imagination-pits-vulkan-api-against-opengl-in-gnomes-per-second-test

Render with Vulkan





Reference : Vulkan Tutorial, https://vulkan-tutorial.com/

Overview of this paper

- Parallel, particle-based, real-time
- Simplifications to achieve real-time effect:
  - Discretizes snow into particles of uniform radius
  - Density computation
  - Others in math and physics
- Use CUDA for attributes computation:
  - Cohesive forces
  - Thermodynamics
  - Compression

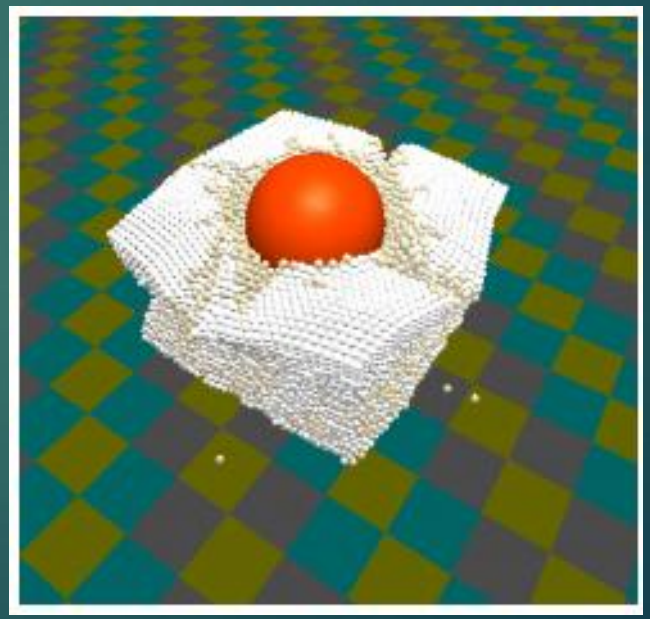
Algorithm 1 Snow Simulation

```
1:  while (animating) do
2:      for all particle i do
3:          find neighborhoods N_i(t)
4:      for all particle i do
5:          compute CohesionForces_i(t)
6:          compute Thermodynamics_i(t)
7:          compute Compression_i(t)
8:      for all particle i do
9:          update velocity v(t + Δt)
10:         update particle position x(t + Δt)
```

Reference : Prashant Goswami, Christian Markowicz, Ali Hassan, Real-time particle-based snow simulation on the GPU

Goals for next milestone

- Implement the math and physics parts
- Perform the attributes computation on CUDA
- Achieve the basic simulation of snow
- Work on Vulkan to visualize the snow particles, add camera and user interactive functions and mesh loading



Reference : Prashant Goswami, Christian Markowicz, Ali Hassan, Real-time particle-based snow simulation on the GPU

References

- Real-time particle-based snow simulation on the GPU

  https://www.diva-portal.org/smash/get/diva2:1320769/FULLTEXT01.pdf

- A material point method for snow simulation

  https://www.math.ucla.edu/~jteran/papers/SSCTS13.pdf

- Nvidia: use GPU to simulate fluid

  https://developer.nvidia.com/gpugems/gpugems/part-vi-beyond-triangles/chapter-38-fast-fluid-dynamics-simulation-gpu

- Vulkan Tutorial

  https://vulkan-tutorial.com/Introduction