Intro to Computer Graphics: Just enough OpenGL

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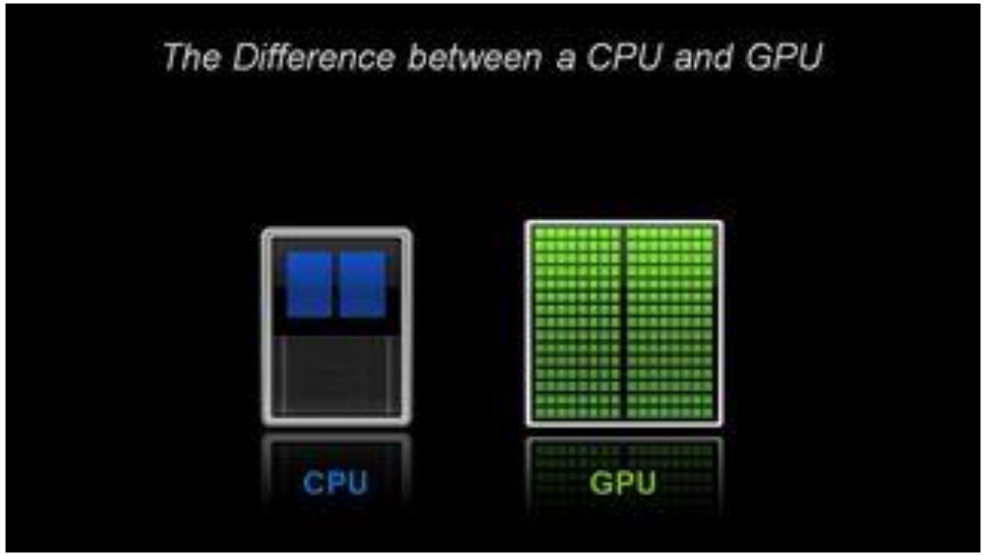
Graphics Processing Unit (GPU)

- GPU VS CPU
  - CPU: Running instructions over a few cores with lots of cache memory
  - GPU: Sharing instructions over many simple cores
- Can accelerate some software by 100x



"GPUs are optimized for taking huge batches of data and performing the same operation over and over very quickly, unlike PC microprocessors, which tend to skip all over the place."
– *Nathan Brookwood, Insight 64 principal analyst*

Source: https://blogs.nvidia.com/blog/2009/12/16/whats-the-difference-between-a-cpu-and-a-gpu/

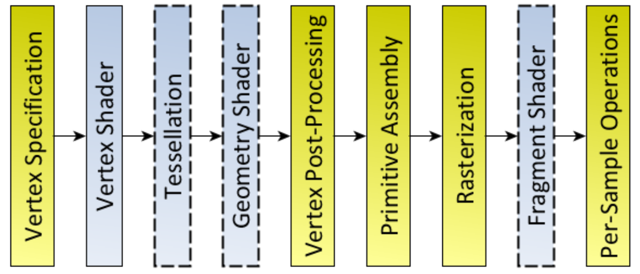
Graphics API

- Graphics API is a specification that describes the behaviour of rasterization-based rendering system
  - Implemented by hardware manufacturer
  - Standard API allows applications to run on different kinds of graphical hardware
- Drivers translate OpenGL API commands into GPU commands
  - Defect in graphics is often due to the hardware, not the library
- Examples:
  - OpenGL, Vulkan (low-level), CUDA (Nvidia, low-level), DirectX (Microsoft)

Source: https://developer.samsung.com/tech-insights/vulkan/what-is-a-graphics-api
Source: https://www.khronos.org/opengl/wiki/FAQ

OpenGL – "**Open** **G**raphics **L**ibrary"

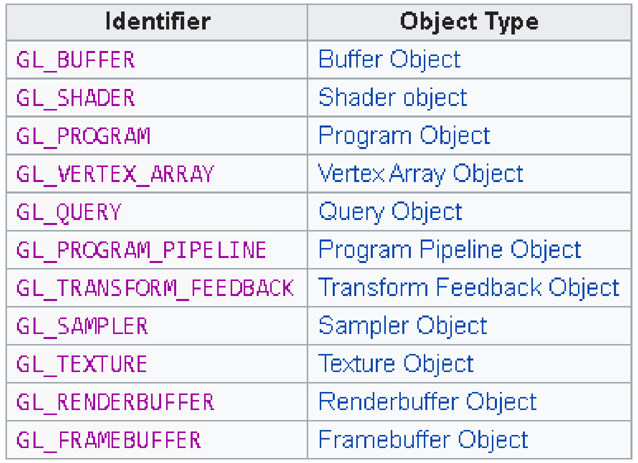
- Rendering Pipeline: Sequence of steps taken to render objects
- Immediate mode vs Core-profile
  - Immediate mode: Pipeline is fixed; developers are limited to existing functions;
    - inefficient, but easy to learn
  - Core-profile: Pipeline is modular; development is flexible by editing parts of pipeline
    - more flexible and efficient, but more difficult to learn



Source: https://learnopengl.com/Getting-started/OpenGL
Source: https://www.khronos.org/opengl/wiki/Rendering_Pipeline_Overview

OpenGL – Open Graphics Library

- OpenGL is a state machine
  - *State*: information used by the rendering system (e.g. vertex position, colour)
  - *Objects*: container for OpenGL's states (e.g. vertex array object)
  - *OpenGL Context*: object that holds all of OpenGL



Identifier	Object Type
GL_BUFFER	Buffer Object
GL_SHADER	Shader object
GL_PROGRAM	Program Object
GL_VERTEX_ARRAY	Vertex Array Object
GL_QUERY	Query Object
GL_PROGRAM_PIPELINE	Program Pipeline Object
GL_TRANSFORM_FEEDBACK	Transform Feedback Object
GL_SAMPLER	Sampler Object
GL_TEXTURE	Texture Object
GL_RENDERBUFFER	Renderbuffer Object
GL_FRAMEBUFFER	Framebuffer Object

Source: https://www.khronos.org/opengl/wiki/OpenGL_Object
Source: https://www.khronos.org/opengl/wiki/OpenGL_Context

OpenGL Loading Library

- Library that loads pointers to OpenGL functions
  - required to access functions from OpenGL versions above 1.1
  - abstracts away the difference between the loading mechanisms on different platforms
- We’ll be using “glad” (Multi-Language GL/GLES/EGL/GLX/WGL Loader-Generator)

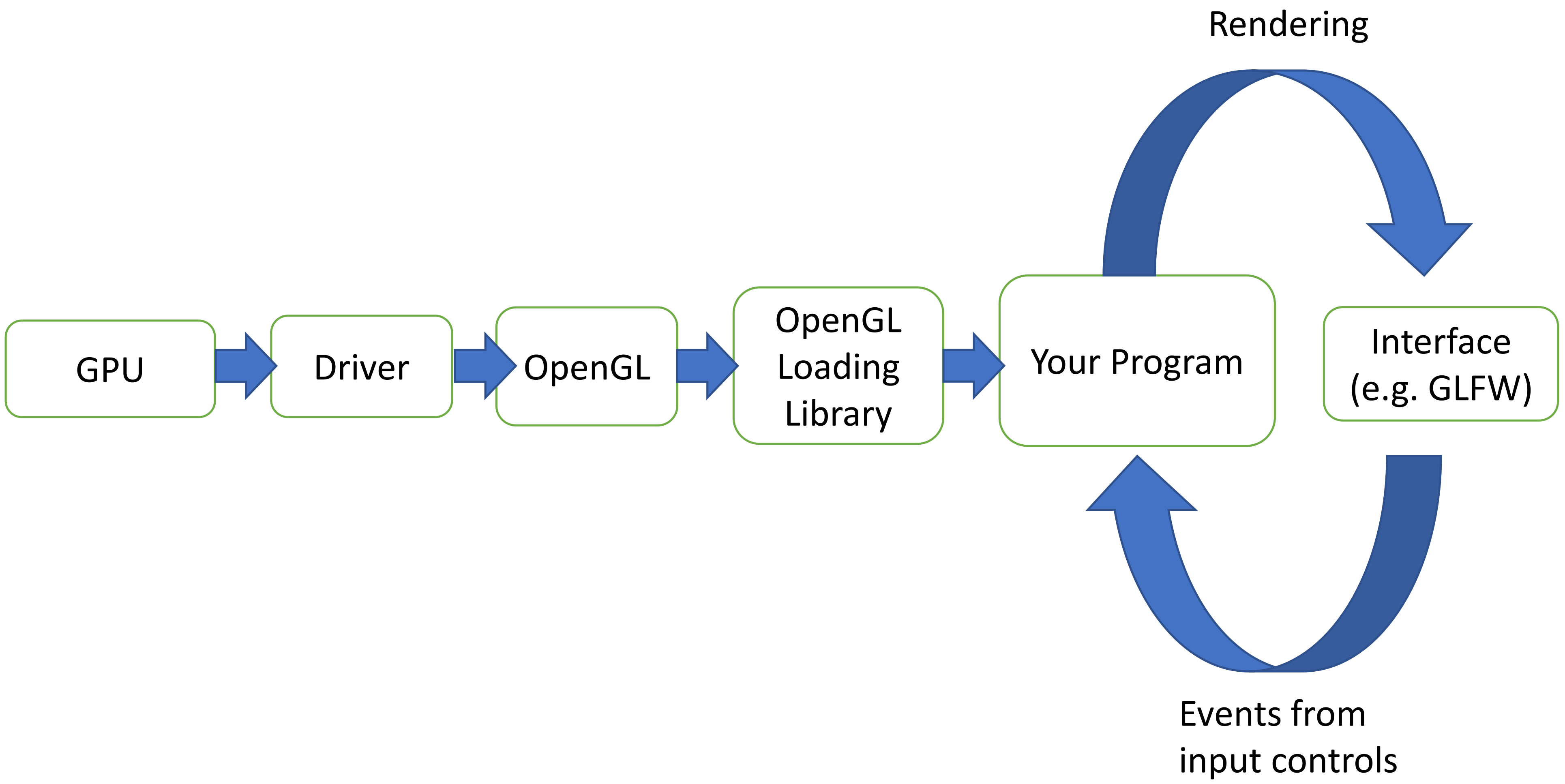
Source: https://www.khronos.org/opengl/wiki/OpenGL_Loading_Library

GLFW – “**G**raphics **L**ibrary **F**rame**W**ork”

- Utility library to create and manage windows, OpenGL context, and input controls (e.g. mouse & keyboard input)

Source: https://www.glfw.org/

Putting it together


Rendering
GPU
Driver
OpenGL
OpenGL Loading Library
Your Program
Interface (e.g. GLFW)
Events from input controls