

# Other GPU frameworks

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**GPU Training, RAL**  
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# GPU language recap

Everything has

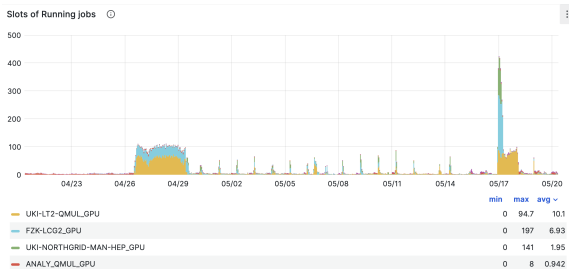
- ▶ Host compiler (e.g. gcc)
- ▶ Device compiler (e.g. nvcc, hipcc)
- ▶ API to allocate memory, synchronise etc (cudaMalloc, cudaDeviceSynchronize)

Language extensions have

- ▶ Extra syntax for indicating device functions

# CUDA advantages

- ▶ CUDA is the frontrunner
- ▶ Nvidia hardware is the most commonly installed
  - ▶ E.g. no ATLAS grid sites with non-Nvidia GPUs (for now!)



# CUDA

- ▶ Very powerful, but only runs on Nvidia hardware
- ▶ Cannot compile for CPU only
  - ▶ [Ocelot](#) project aims to make this possible, but does not have official support

# AMD GPUs

## History

- ▶ ATI video game graphics cards
- ▶ Bought by AMD in 2006
- ▶ General purpose GPU programming with ROCm framework, HIP language/compiler

Replacement parts available

ATI RAGE FURY - True 32-bit color without compromising speed



**ATI GENUINE ATI REPLACEMENT PARTS**  
*Eyeballs and veins for gamers*

**ATI RAGE FURY**

- Only RAGE FURY delivers sinfully fast 32-bit and 32-bit color rendering without compromising 3D frame rate performance
- Packed with 32MB of memory and the latest 128-bit 3D graphics engine available today
- Features hardware DVD and TV-out for big screen gaming
- Supports ATI TV WONDER, the TV tuner add-on board
- Check out the 32-bit true color showcase at [www.atitech.com](http://www.atitech.com) for the hottest information on true color and all the latest 32-bit true color games



**QUAKE II FRAME RATES**

ATI RAGE FURY	64 fps
ATI RAGE FURY 128 MB	64 fps
ATI RAGE FURY 256 MB	64 fps
ATI RAGE FURY 512 MB	64 fps
ATI RAGE FURY 1024 MB	64 fps
ATI RAGE FURY 2048 MB	64 fps
ATI RAGE FURY 4096 MB	64 fps
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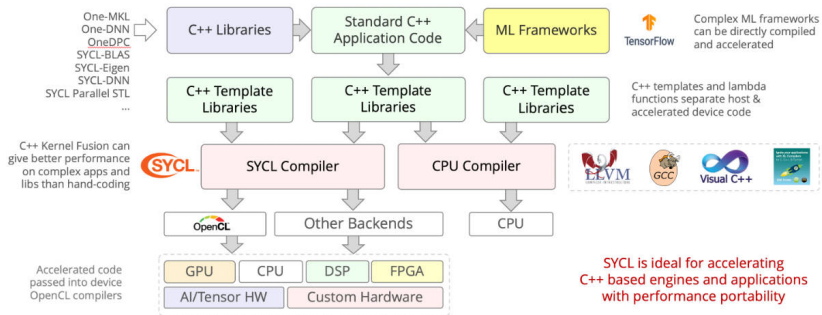
# ROCm/HIP

- ▶ Syntax similar to CUDA
- ▶ Find and replace possible for basic programs
- ▶ Similar ecosystem available, but less user-friendly

```
hipify-perl vector_add.cu > vector_add.hip  
hipcc -o hipify_vector_add vector_add.hip
```

# SYCL

- ▶ Open standard, pushed by Intel
- ▶ Implementations for all GPU vendors and CPU (also Intel/Altera FPGA)



- ▶ More details and examples [here](#)



- ▶ Clever C++ (templates, mainly) to generate a variety of different backends
- ▶ Can write something similar to CUDA or SYCL

### Accelerator Back-ends

Accelerator Back-end	Lib/API	Devices	Execution strategy grid-blocks	Execution strategy block-threads
Serial	n/a	Host CPU (single core)	sequential	sequential (only 1 thread per block)
OpenMP 2.0+ blocks	OpenMP 2.0+	Host CPU (multi core)	parallel (preemptive multitasking)	sequential (only 1 thread per block)
OpenMP 2.0+ threads	OpenMP 2.0+	Host CPU (multi core)	sequential	parallel (preemptive multitasking)
std::thread	std::thread	Host CPU (multi core)	sequential	parallel (preemptive multitasking)
TBB	TBB 2.2+	Host CPU (multi core)	parallel (preemptive multitasking)	sequential (only 1 thread per block)
CUDA	CUDA 9.0+	NVIDIA GPUs	parallel (undefined)	parallel (lock-step within warps)
HIP(clang)	<a href="#">HIP 5.1+</a>	AMD GPUs	parallel (undefined)	parallel (lock-step within warps)



# Kokkos

- ▶ Contains higher-level abstractions
- ▶ Good support

```
#include <Kokkos_Core.hpp>
#include <cstdio>
#include <typeinfo>

struct hello_world {
    KOKKOS_INLINE_FUNCTION
    void operator()(const int i) const {
        Kokkos::printf("Hello from i = %i\n", i);
    }
};

int main(int argc, char* argv[]) {
    Kokkos::initialize(argc, argv);

    printf("Hello World on Kokkos execution space %s\n",
           typeid(Kokkos::DefaultExecutionSpace).name());
    Kokkos::parallel_for("HelloWorld", 15, hello_world());
    Kokkos::finalize();
}
```

## Summary of major options

	NVidia	AMD	Intel	CPU
CUDA	✓	✗	✗	Ish
HIP	✓	✓	Ish	Ish
SYCL	✓	✓	✓	✓
Alpaka	✓	✓	✓	✓
Kokkos	✓	✓	✓	✓

# The future? standard C++

- ▶ From C++17 onwards, four execution policies:
  - ▶ `std::execution::seq`: Sequential execution. No parallelism is allowed.
  - ▶ `std::execution::unseq`: Vectorized execution on the calling thread (this execution policy was added in C++20).
  - ▶ `std::execution::par`: Parallel execution on one or more threads.
  - ▶ `std::execution::par_unseq`: Parallel execution on one or more threads, with each thread possibly vectorized.
- ▶ Support from compilers
- ▶ Interest from NVidia
- ▶ Could eventually write standard C++ and specify target GPU at compile-time...
- ▶ But we're not there yet

## Comparison with writing performant CPU code

- ▶ Using all the capabilities of a modern x86 CPU doesn't happen out-of-the-box
- ▶ Still takes significant expertise to get good performance despite 20 years of x86 standard: compilers are clever but don't do everything
- ▶ But we can at least
  - ▶ Compile for ARM, PowerPC without too much effort and get something that largely works
  - ▶ Get something that works on Intel and AMD x86 (limited vendor changes)

# Live demo

[StewMH/gpu\\_translate](#) on GitHub