



Hands-On HPC Application Development Using C++ and SYCL

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DEVICE DISCOVERY

LEARNING OBJECTIVES

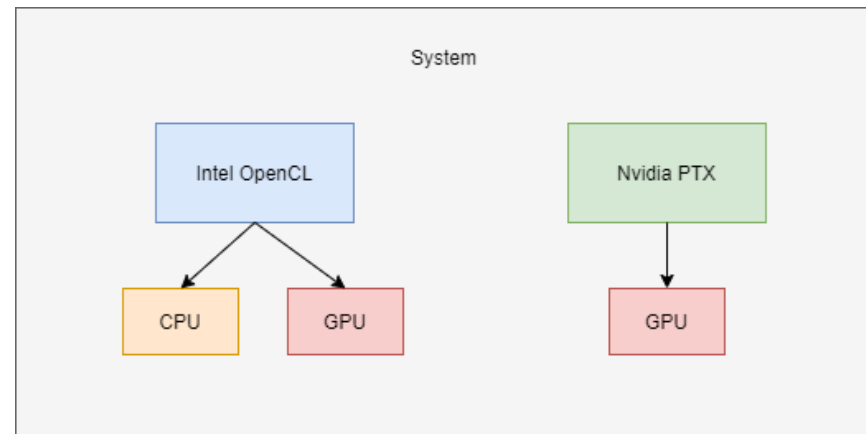
- Learn about the SYCL system topology and how to traverse it
- Learn how to query information about a platform or device
- Learn how to select a device; both manually and using device selectors

SYCL SYSTEM TOPOLOGY

- A SYCL application can execute work across a range of different heterogeneous devices.
- The devices that are available in any given system are determined at runtime through topology discovery.

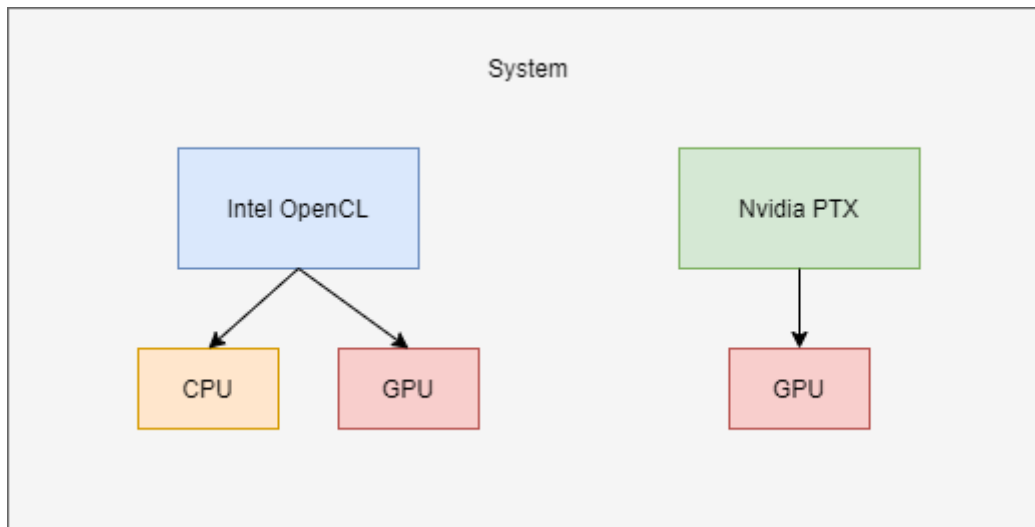
PLATFORMS AND DEVICES

- The SYCL runtime will discover a set of platforms that are available in the system.
 - Each platform represents a backend implementation such as Intel OpenCL or Nvidia PTX.
- The SYCL runtime will also discover all the devices available for each of those platforms.
 - CPU, GPU, FPGA, and other kinds of accelerators.



PLATFORM AND DEVICE CLASSES

- Platforms and devices are represented by the platform and device classes respectively.

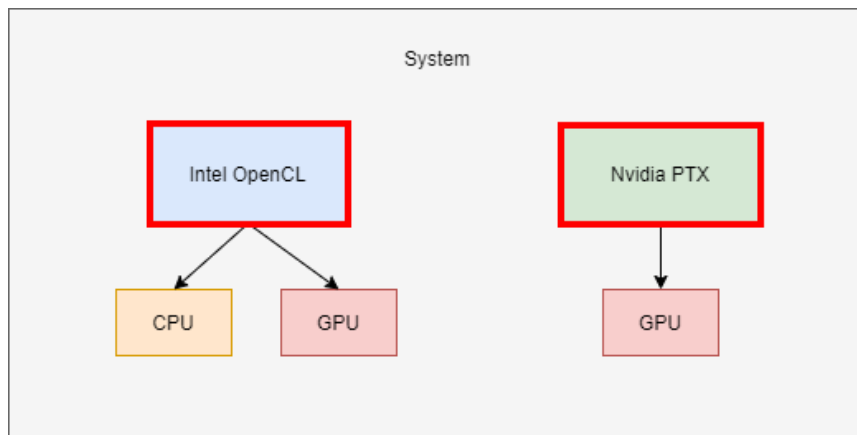


QUERYING THE TOPOLOGY

- In SYCL there are two ways to query a system's topology.
 - The topology can be manually queried and iterated over via APIs of the platform and device classes .
 - The topology can be automatically queried and iterated over using a use specified heuristic by a device selector object.

QUERYING MANUALLY

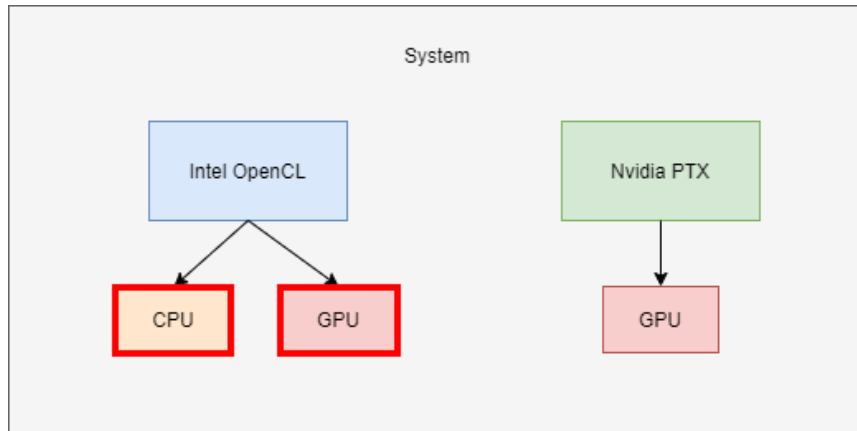
```
auto platforms = platform::get_platforms();
```



- The platform class provides the static function `get_platforms`.
- It retrieves a vector of all available platforms in the system.

QUERYING MANUALLY

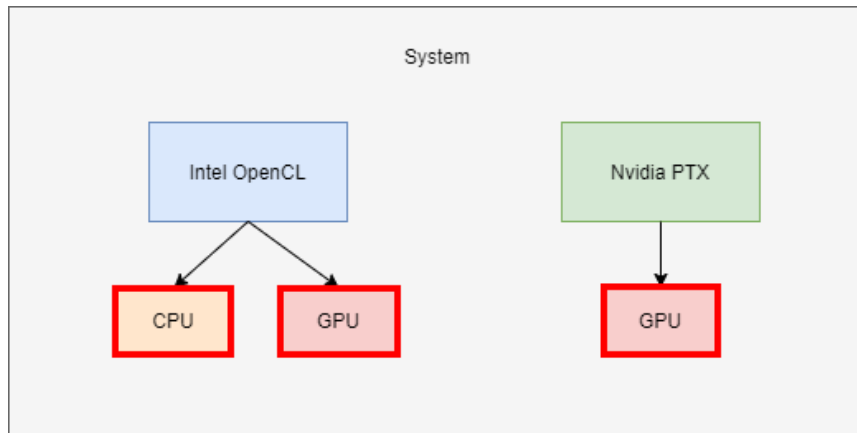
```
auto intelDevices = intelPlatform.get_devices();
```



- The platform class provides the member function `get_devices` that returns a vector of all devices associated with that platform.

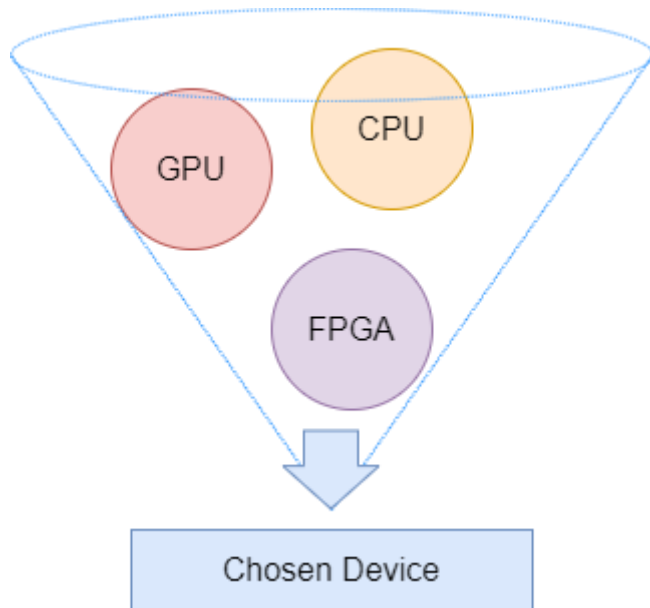
QUERYING MANUALLY

```
auto devices = device::get_devices();
```



- The device class also provides the static function `get_devices` that returns a vector of all available devices in the system.

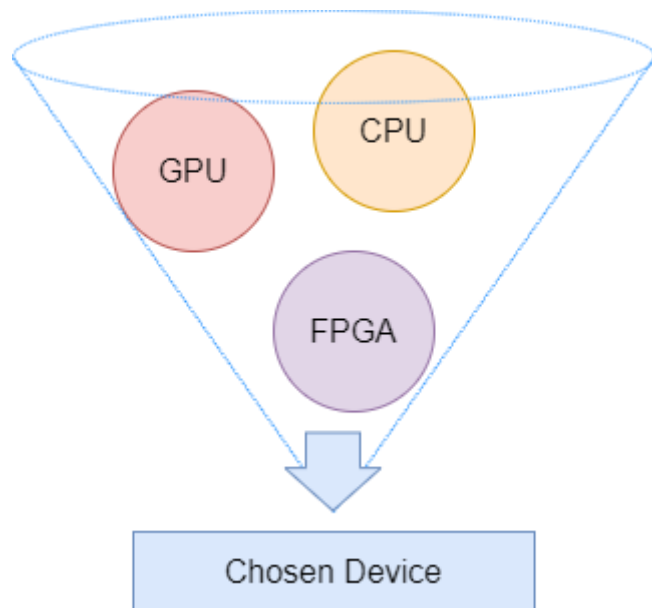
QUERYING WITH A DEVICE SELECTOR



- To simplify the process of traversing the system topology SYCL provides device selectors.
- A device selector is is a callable C++ object which defines a heuristic for scoring devices.
- SYCL provides a number of standard device selectors, e.g. `default_selector_v`, `gpu_selector_v`, etc.
- Users can also create their own device selectors.

QUERYING WITH A DEVICE SELECTOR

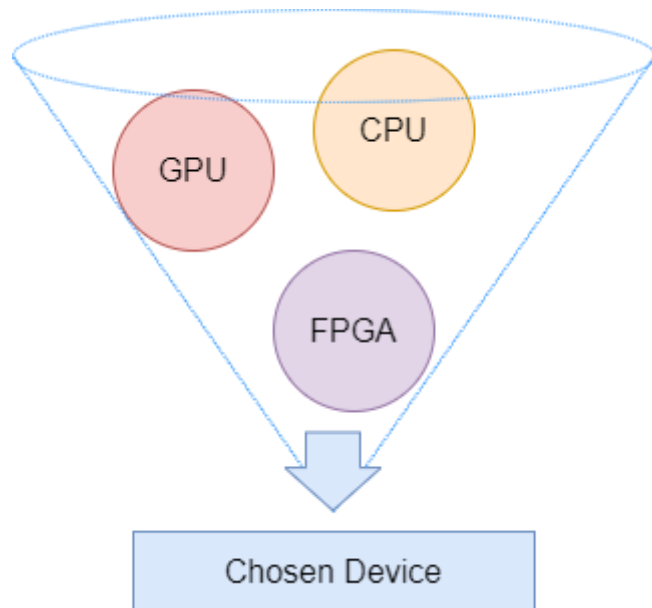
```
auto gpuDevice = device(gpu_selector_v);
```



- A device selector takes a parameter of type `const device &` and gives it a "score".
- Used to query all devices and return the one with the highest "score".
- A device with a negative score will never be chosen.

QUERYING THE TOPOLOGY USING A DEVICE SELECTOR

```
auto chosenDevice = device();  
auto chosenDevice = device(default_selector_v);
```



- The `default_selector_v` is a standard device selector.
- Chooses a device based on an implementation defined heuristic.
- A default constructed device or platform will use this selector.

CREATING A CUSTOM DEVICE SELECTOR

```
int my_gpu_selector(const device& dev) {  
  
}
```

- A device selector can be any callable object.
- A device selector must have a function call operator which takes a reference to a device.

CREATING A CUSTOM DEVICE SELECTOR

```
int my_gpu_selector(const device& dev) {  
    if (dev.is_gpu()){  
        return 1;  
    }  
    else {  
        return -1;  
    }  
}
```

- The body of the function call operator defines the heuristic for selecting devices
- This is where you write the logic for scoring each device

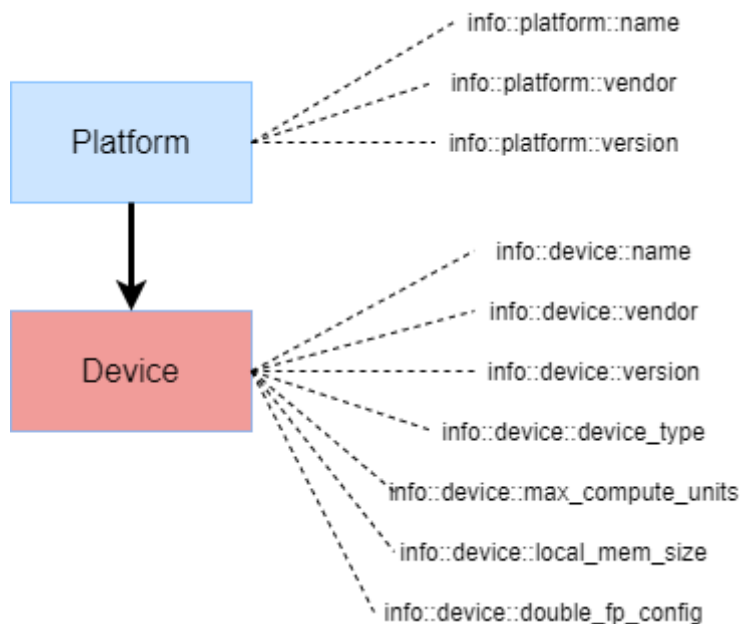
CREATING A CUSTOM DEVICE SELECTOR

```
int my_gpu_selector(const device& dev) {  
    if (dev.is_gpu()){  
        return 1;  
    }  
    else {  
        return -1;  
    }  
}  
  
int main(int argc, char *argv[]) {  
    auto gpuQueue = queue{my_gpu_selector};  
}
```

- Now that there is a device selector that chooses a specific device we can use that to construct a queue.

PLATFORM/DEVICE INFO

```
auto plt = dev.get_platform();  
auto platformName  
    = dev.get_info<info::device::name>();
```



- Information about platforms and devices can be queried using the template member function `get_info`.
- The info that you are querying is specified by the template parameter.
- You can also query a device for its associated platform with the `get_platform` member function.

ASPECTS

```
bool supportsFp16 = dev.has(aspect::fp16);
```

- Capabilities of a device or platform are represented by aspects.
- These can be queried via the **has** member function.

QUESTIONS?

EXERCISE

Lesson_Materials/Lecture_04_Device_Selections

Create your own device selector that chooses the device in your system that you would like to target.

Hint: Look at Figure 12-4 in the book and the text that preceeds it.