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Events Events Events

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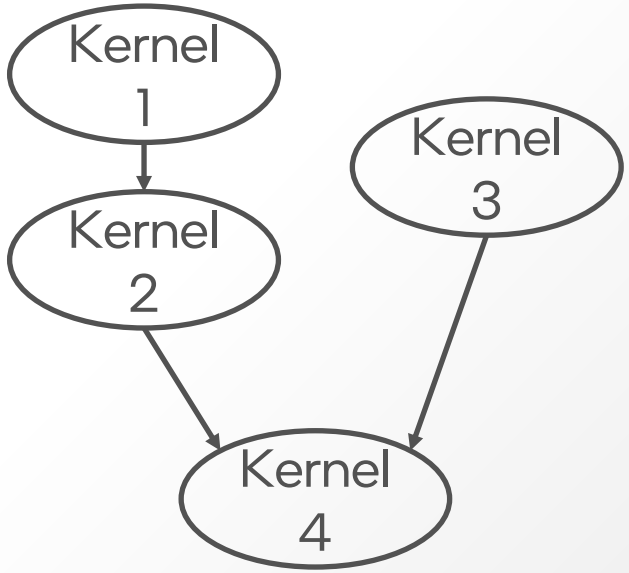
...clearly NOT
using SYCL

Dependences in SYCL

Two views:

1. Data - buffers/accessors

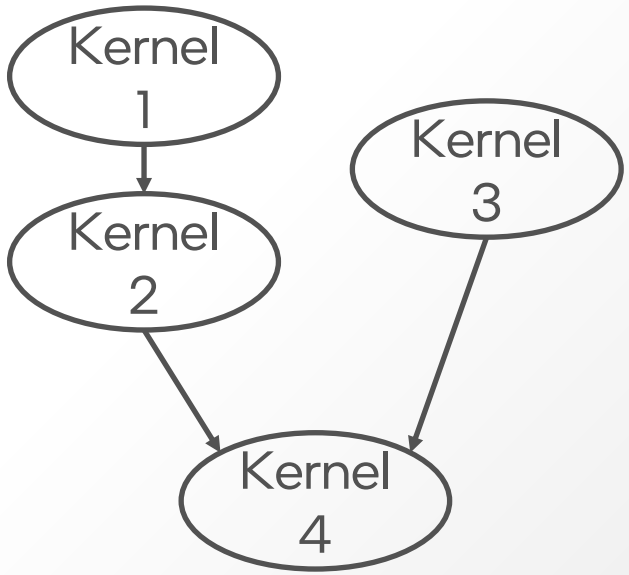



```
int main() {
  auto R = range{num};
  buffer<int> A{R}, B{R};
  queue Q;

  Q.submit([&](handler& h) {
    accessor out{A, h};
    h.parallel_for(R, [=](auto idx) {
      /* Kernel 1 */ }); });

  Q.submit([&](handler& h) {
    accessor inout{A, h};
    h.parallel_for(R, [=](auto idx) {
      /* Kernel 2 */ }); });

  Q.submit([&](handler& h) {
    accessor out{B, h};
    h.parallel_for(R, [=](auto idx) {
      /* Kernel 3 */ }); });

  Q.submit([&](handler& h) {
    accessor in{A, h, read_only};
    accessor inout{B, h, read_write};
    h.parallel_for(R, [=](auto idx) {
      /* Kernel 4 */ }); });
}
```

Dependences in SYCL

Two views:

2.Task - events




```
int main() {
  auto R = range{num};
  int *A, *B = /* … */;
  queue Q;

  event e1 = Q.submit([&](handler& h) {
    h.parallel_for(R, [=](auto idx) {
      /* Kernel 1 */ }); });

  event e2 = Q.submit([&](handler& h) {
    h.depends_on(e1);
    h.parallel_for(R, [=](auto idx) {
      /* Kernel 2 */ }); });

  event e3 = Q.submit([&](handler& h) {
    h.parallel_for(R, [=](auto idx) {
      /* Kernel 3 */ }); });

  Q.submit([&](handler& h) {
    h.depends_on({e2, e3});
    h.parallel_for(R, [=](auto idx) {
      /* Kernel 4 */ }); });
}
```

SYCL Events

The hammer of synchronization and utility!

- In SYCL 2020, every command returns an event
- USM relies on event-based synchronization (OoO queues)
- Command execution status is reported via an event
- Profiling info is provided via an event

… if they're so useful, what's the problem?

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Or … you pay for what you get:

- Event creation has a cost
  - In some implementations, a backend event is ALWAYS created
  - Sometimes events are never used (or immediately destroyed)!
    - In-order queues
    - No cross-queue synchronization
- Event profiling is all-or-none
  - Profiling enabled via property at queue creation
  - Profiling enabled for ALL commands in queue

Event Profiling

Event profiling is enabled via a queue property.

- Enabled at queue creation
- Can’t be toggled on/off later

Works, but too coarse

- Sometimes only parts of execution matter
- Code may want to easily toggle profiling
- Semantic mismatch when migrating code from CUDA/HIP

Can we do better?

Existing Extensions for Unwanted Events:

- "Discard Events" – DPC++
  - sycl_ext_oneapi_discard_queue_events
  - Queue property that doesn't *really* create events
- "Coarse Grained Events" – AdaptiveCpp
  - AdaptiveCpp/doc/extensions.md at develop
  - Queue/Command Group property to optimize behavior, assuming you won't usually try to use the events

Didn’t that fix it?

Neither solution is ideal:

- Discard events leaves ticking time bombs in the code
- Both require programmer annotations
- Annotations may be separate from use
  - Harder to reason about what code does and how it acts

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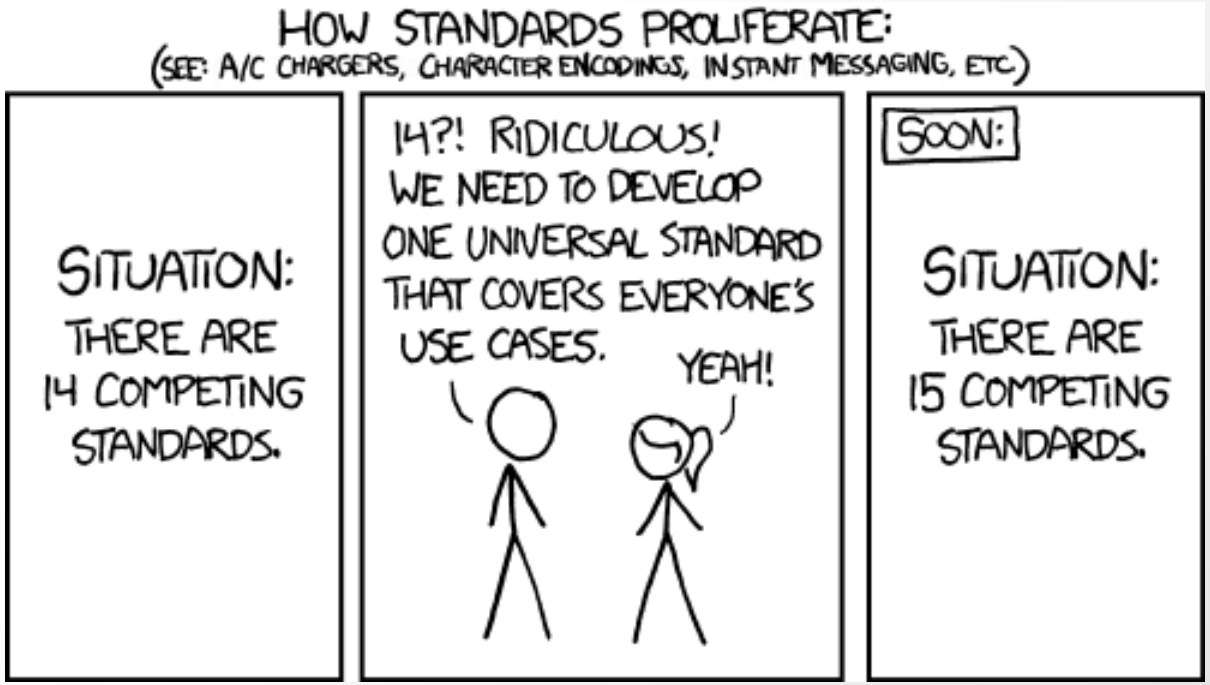
Solution: More Extensions!



https://xkcd.com/927/

Complexity should be “opt-in”

“Events by default”

- In SYCL for ages
- Semantic break from OpenCL
  - Events are *optional* in OpenCL
  - Why did SYCL make them *mandatory*?

Queue-based event profiling

- Too coarse
- Too inflexible

Time to fix our technical debt.

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New Enqueue Functions to the Rescue!

The best way to eliminate events is to never create them at all.

- sycl_ext_oneapi_enqueue_functions
- Two new APIs:

1)
```
template <typename CommandGroupFunc>
  void submit(sycl::queue q,
              CommandGroupFunc&& cgf);
```

2)
```
template <typename CommandGroupFunc>
  sycl::event submit_with_event(sycl::queue q,
                                CommandGroupFunc&& cgf);
```

Profiling Tags

Let the user decide what to profile when.

- Profiling tags extension
  - sycl_ext_oneapi_profiling_tag
- One new API:
  - For OoO queues, synchronizes with a barrier that is used as a marker
  - For in-order queues, just enqueues a marker

```
#include <iostream>
#include <sycl/sycl.hpp>
namespace syclex = sycl::ext::oneapi::experimental;
namespace prof = sycl::info::event_profiling;

static constexpr size_t N = 1024;

int main() {
  sycl::queue q; // q created WITHOUT profiling enabled


  // commands submitted here are not timed

  sycl::event start = syclex::submit_profiling_tag(q);
  syclex::parallel_for(q, {N}, [=](auto i) {/* first kernel */});
  syclex::parallel_for(q, {N}, [=](auto i) {/* second kernel */});
  sycl::event end = syclex::submit_profiling_tag(q);

  q.wait();

  uint64_t elapsed =
    end.get_profiling_info<prof::command_start>() -
    start.get_profiling_info<prof::command_end>();

  std::cout << "Execution time: " << elapsed << "(ns)\n";

  return 0;
}
```

*Works for most backends. OpenCL will require an extension.

Summary

Events are an incredibly powerful part of SYCL!

- Tool for synchronization and measurement
- Current use in SYCL may have drawbacks

Proposed new extensions:

- New Enqueue Functions
- Profiling Tags

Pay for what you use - not for what you don't!

Questions?

Check out DPC++: intel/llvm: Intel staging area for llvm.org contribution. Home for Intel LLVM-based projects. (github.com)

Check out oneAPI Toolkits: oneAPI: A New Era of Heterogeneous Computing (intel.com)

Comment/Contribute for SYCL Upstreaming to Clang!


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