oneAPI Technical Advisory Board Meeting: Local Memory Allocation

08-26-2020

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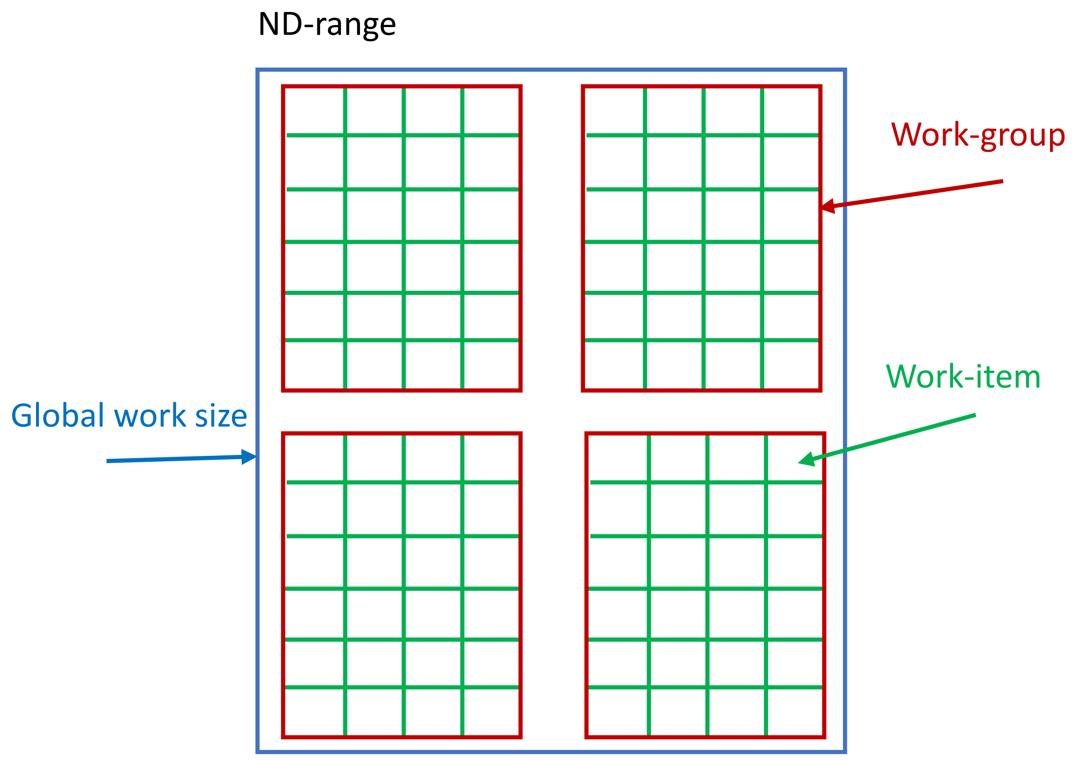
Re-cap: Local Memory in SYCL Today

- Work-items in an ND-range are grouped into 1-, 2- or 3-dimensional work-groups.
- Work-items in the same work-group can communicate via work-group local memory.
- Local memory may be mapped to dedicated hardware memory where available.



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Re-cap: Local Memory in SYCL Today

SYCL only permits local memory allocations via a `local_accessor`, declared outside of the kernel:

```
q.submit([&](handler& cgh) {
  auto local = local_accessor<uint32_t, 1>(range<1>{L}, cgh);
  cgh.parallel_for(nd_range<1>{N, L}, [=](nd_item<1> item) {
    ...
  })
});
```

...we'd like to change that, to simplify programming, and to separate local memory allocations from the restrictions of accessors.

Proposal

```
template <typename T, typename Group, typename... Args>
T& group_local_memory(Group g, Args... args);

template <typename T, typename Group>
T& group_local_memory_for_overwrite(Group g);

q.parallel_for(nd_range<1>{N, L}, [=](nd_item<1> it) {
  uint32_t&   initialized = *group_local_memory<uint32_t>(it.get_group(), 42);
  uint32_t& uninitialized = *group_local_memory_for_overwrite<uint32_t>(it.get_group());
});
```

- Allowed at kernel scope (like OpenCL `local`) and function scope
- Returns a `multi_ptr` to an object allocated once for the specified group in `local` address space
- Object is initialized upon or before first call to `group_local_memory` (like `thread_local`)
- Object's lifetime is tied to the group, so behaves like a `static` variable
- Uniform argument pack forwarded to constructor (like `make_unique`)

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Realistic Example - Arrays

```
q.parallel_for(nd_range<1>{N, L}, [=](nd_item<1> it) {

  // Create uninitialized scratchpad to be filled later
  auto array = *group_local_memory_for_overwrite<uint32_t[2][2]>(
                 it.get_group());

  // Create array with initial state
  auto array = *group_local_memory<uint32_t[2][2]>(
                 it.get_group(), {x, y, z, w});

});
```

Potential Issues & Discussion

- Who calls the destructor?
  - We propose to limit to trivially destructible types (for now) to avoid this issue

- What about library-only implementations?
  - Kernel scope is straightforward, if allocations appear before any other code
  - Arbitrary scopes is hard; would need a way to uniquely identify each function call
    - `std::source_location` is insufficient
    - Do we need to work towards something like a `std::unique_location`?

- Is this extension still useful with these limitations?
  - i.e. trivially destructible types, allocations only at kernel scope

- Does this proposal address concerns about `local_accessor`?
  Are there alternative designs to consider?

Rules of the Road

- DO NOT share any confidential information or trade secrets with the group
- DO keep the discussion at a High Level
  - Focus on the specific Agenda topics
  - We are asking for feedback on features for the oneAPI specification (e.g. requirements for functionality and performance)
  - We are <u>NOT</u> asking for feedback on any implementation details
- Please submit any implementation feedback in writing on Github in accordance with the Contribution Guidelines at spec.oneapi.com. This will allow Intel to further upstream your feedback to other standards bodies, including The Khronos Group SYCL* specification.

Notices and Disclaimers