SYCL (traditional)

Developed by : Benson Muite, benson_muite@emailplus.org
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GPGPU programming
(General-Purpose Graphics Processing Unit)

- Graphics processing requires many similar operations in “graphics pipeline”
  - Triangles going through rotation and scaling, shading, and texturing

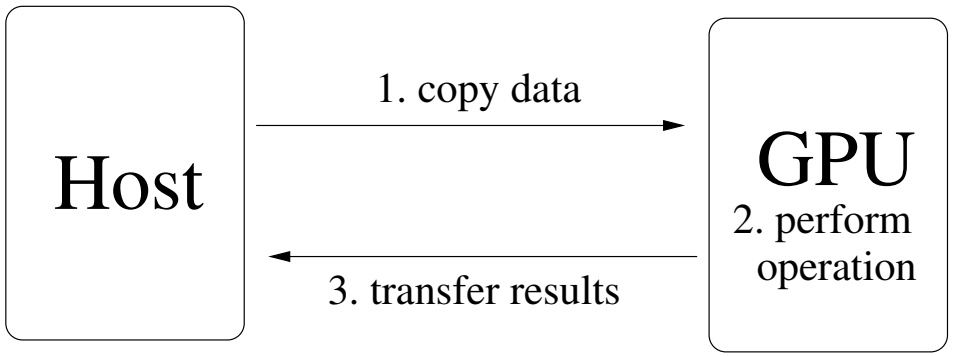
- Graphics Processing Units (GPUs) develop to meet this need and then get converted for general purpose programs

- SYCL is an XPU (GPU, CPU and FPGA) design and extension of C++ to support Heterogeneous programming developed by the Khronos group
  - Alternatives for GPUs include OpenCL, CUDA, ROCm

Programming model: Memory

- Program mainly runs on “Host” (= CPU), but can call functions on “Devices” (= GPU, FPGA, CPU)

- Host and Device can have separate address spaces (at least historically)
  - Memory may need to be explicitly transferred
  - SYCL can automate some of the transfers



Programming model: Processing

- XPU can run many threads simultaneously, but not independently
  - Performance benefits obtained from SIMD = Single Instruction, Multiple Data
  - SYCL abstracts away SIMD parallelism to enable the same code to run on different compute devices
- Programmer writes function to run on device (kernel)
- All the threads run the function

“Hello World” for SYCL

Overview of a SYCL program

- In host code:
  - Setup problem call kernel
- In device code:
  - Allocate memory on device
  - Copy data from host
  - Kernel call
  - Copy results to host (can be done implicitly on expiry of scope)
  - Free device memory (can be done implicitly on expiry of scope)
  - q.submit([&](cl::sycl::handler& cgh)
  - determine thread ID
  - bounds check

Adding vectors and Hello World using SYCL

(Not actually fast…)

Recall: Calling a SYCL kernel

```
cgh.parallel_for<class vector_add>(work_items,
                                   [=] (cl::sycl::id<1> tid)
or
cgh.parallel_for<class hello>(cl::sycl::nd_range<1>{a, b},
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- Why use more than a single block?
  - Limited number of threads per processing element (depends on card being used)
- Why not use N blocks?
  - Threads in a processing unit share variables and have synchronization barriers
  - So, technically limited

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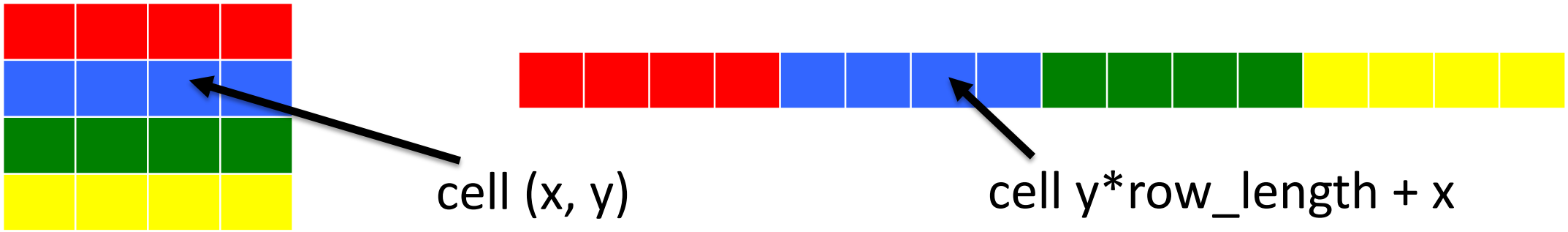

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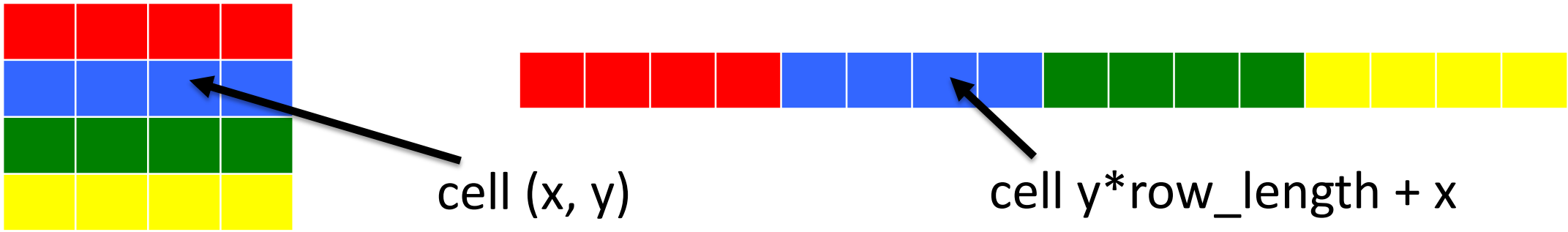

Consider cell with 1D coordinate i:
What is the coordinate of the cell below it?
What expression tests if it is on the right edge?

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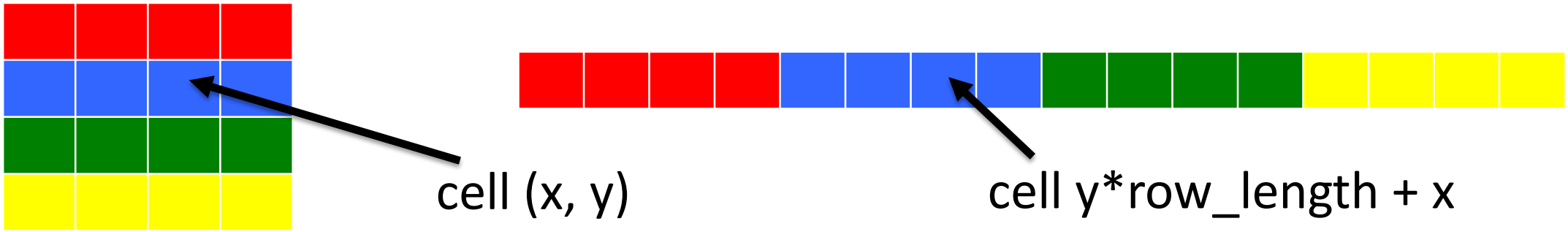

Consider cell with 1D coordinate i:

What is the coordinate of the cell below it? i + row_length

What expression tests if it is on the right edge? i % row_length == row_length – 1