OpenCL C++ kernel language

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OpenCL 2.2

- OpenCL C++
  - Open source free compiler
    - https://github.com/KhronosGroup/libclcxx
    - https://github.com/KhronosGroup/SPIR
- SPIR-V 1.1
- API

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What is OCL C++

- C++14 based
- Portable
- Generic
- Flexible

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C++14 Based

- The same grammar
- Small restrictions and extensions
- Subset of C++14 STL headers
- Language constructions specific for C++14

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Standard library

- Large set of headers
- Features from
  - OpenCL 2.0 C
  - C++14

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Generic & Flexible

- Allows interfacing
- Passing functors
- Meta programming
- Encapsulation

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Design focus

- In the spirit of C++
- Ease of porting from OCL C
- Easily extensible with libraries
- C++ standard library additions
- Alignment with SYCL

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Compile time

- Templates
- Type traits
- Type safety

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Encapsulation

- Classes
- Interfacing
- Lambdas

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Restrictions and limitations

- Function pointers
- Polymorphism
- Dynamic allocations
- Recursive functions
- Exceptions
- RTTI

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Function pointers

- Lack of hardware support
- Compatibility reasons

- Good news:
  - We have functors

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Polymorphism

- V-tables use function pointers

- Good news:
  - CRTP works

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Dynamic allocations

- Compatibility reasons
- Lack of hardware support
- Runtime API changes

- Good news:
  - Placement new and delete work

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Recursive functions

- Lack of physical stack
- Inlining

- Good news
  - Constexpr recursion works as in C++14

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Exceptions and RTTI

- Various performance problems
- Lack of hardware support for exceptions

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Extensions

- Built in vectors
- New attributes
- Address spaces
- Built in half type

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Built in vector types

- Known from OpenCL C
  - Extended construction
  - Vector helper library

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New attributes

- Compiler information
  - max_size
  - required_num_sub_groups
  - ivdep

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Address spaces

- Similar to OpenCL C address spaces
- Implicit
- Templates can be specialized on them
- Separate library

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Half type

- 16bit floating point type
- Native support is provided via extension
- Without support arithmetic on half is emulated

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What's new in comparison to OpenCL C

- Standard library
- Templates
- Classes
- Lambdas

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Standard library from C++

- opencl_type_traits
- opencl_array
- opencl_atomic
- opencl_functional
- opencl_limits
- opencl_iterator
- opencl_tuple
- opencl_def

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Standard library from OpenCL C

- opencl_image
- opencl_common
- opencl_convert
- opencl_device_queue
- opencl_geometric
- opencl_integer
- opencl_pipe
- opencl_printf
- opencl_relational
- opencl_synchronization
- opencl_vector_load_store
- opencl_work_group
- opencl_work_item
- opencl_reinterpret
- opencl_math

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Standard library

- opencl_memory
- opencl_half
- opencl_vector_utility
- opencl_range
- opencl_marker
- opencl_math_constants
- opencl_vector

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Templates, Classes & Lambdas

- Compatible with C++14 standard

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New in OpenCL

- Pipe storage
- Non trivial construction and destruction of the global memory objects in program scope
- Program scope local memory
- New attributes

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Facelifted features from OpenCL C

- Images & Samplers
- Pipes
- Device enqueue
- Address spaces
- All builtins

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Images, Samplers & Pipes

- Type safe
- Various useful typedefs
- Compile time information
- Reduce undefined behavior

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Device enqueue

- Type safe
- Less restrictive
- Simpler syntax

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Address spaces

- Class like interface
- Possible specialization

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Builtin functions

- Many are templated
- Split into headers

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The end