OpenCL™ “SPIR” a Standard Portable IR

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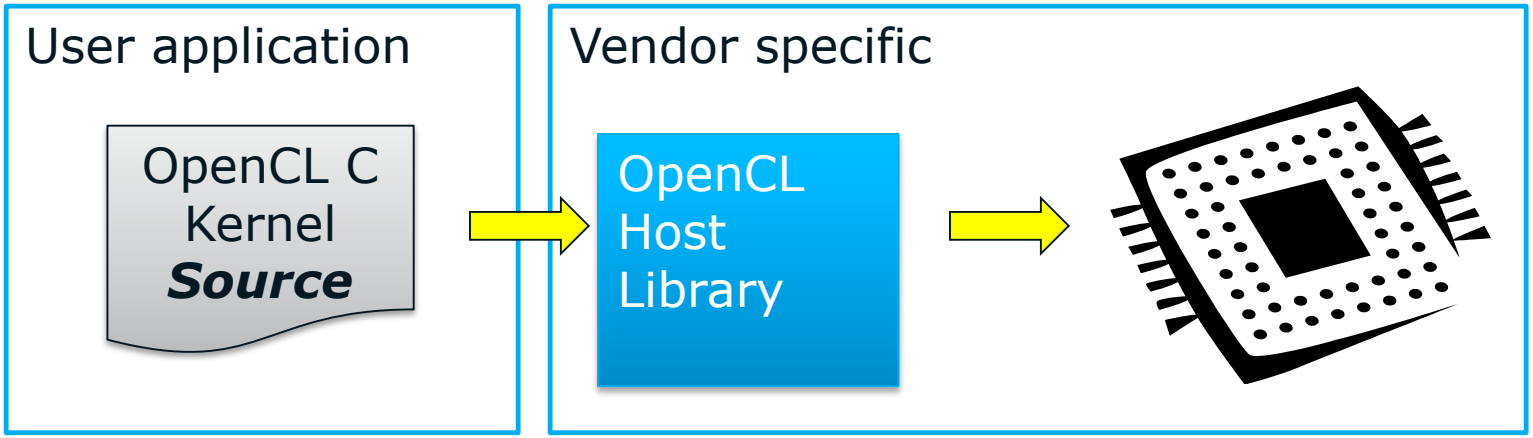
SPIR = Standard Portable Intermediate Representation

- A portable non-source representation for OpenCL 1.2 device programs
- A Khronos initiative
  - SPIR 1.2 preview spec standardizes *consumption*
  - http://www.khronos.org/files/opencl-spir-12-provisional.pdf
- Based on LLVM 3.2
- Open source *generator*: Clang

OpenCL: Source compilation flow

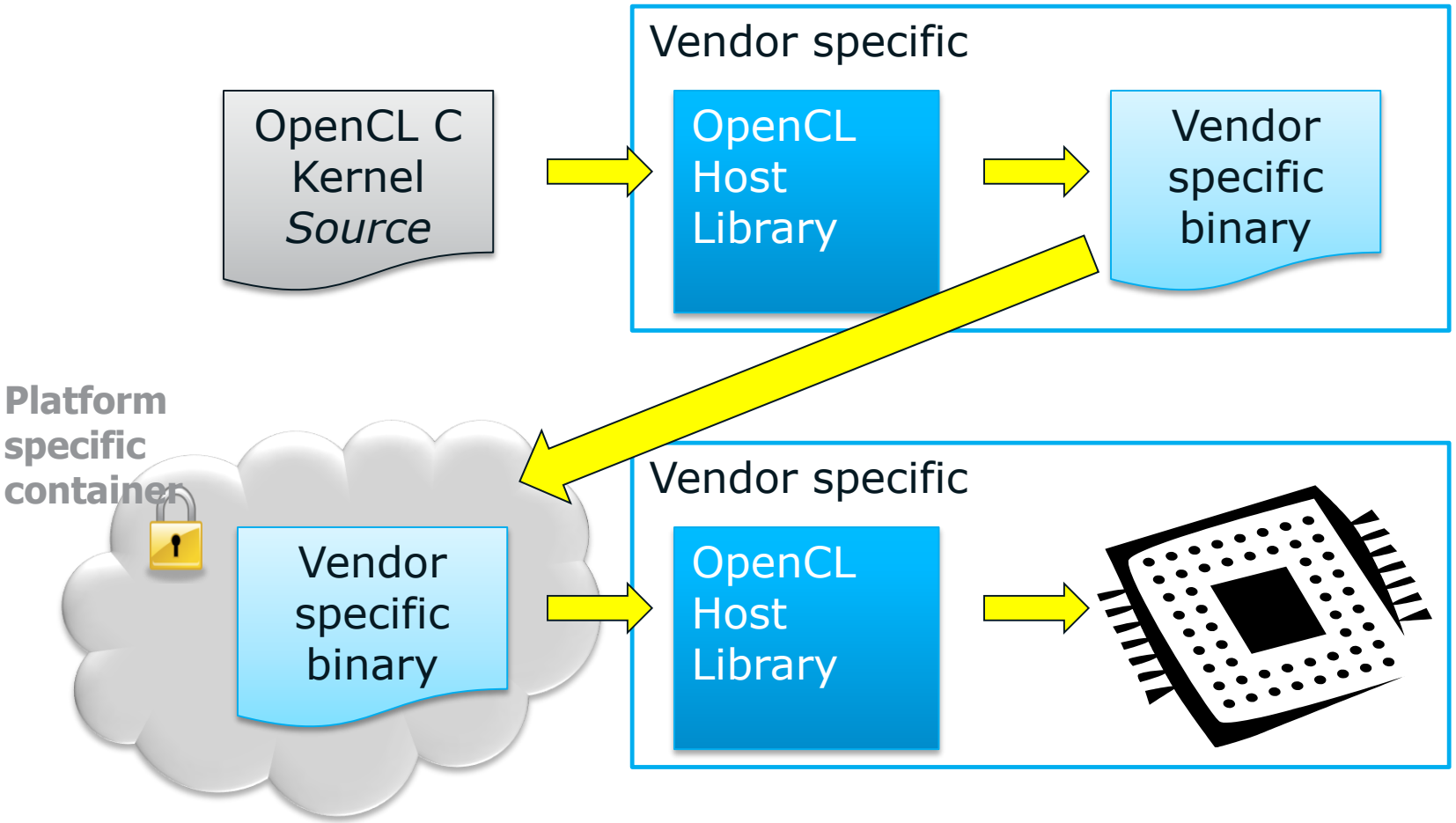


ISV ships their kernel source

- Exposes their IP

Supports only OpenCL C

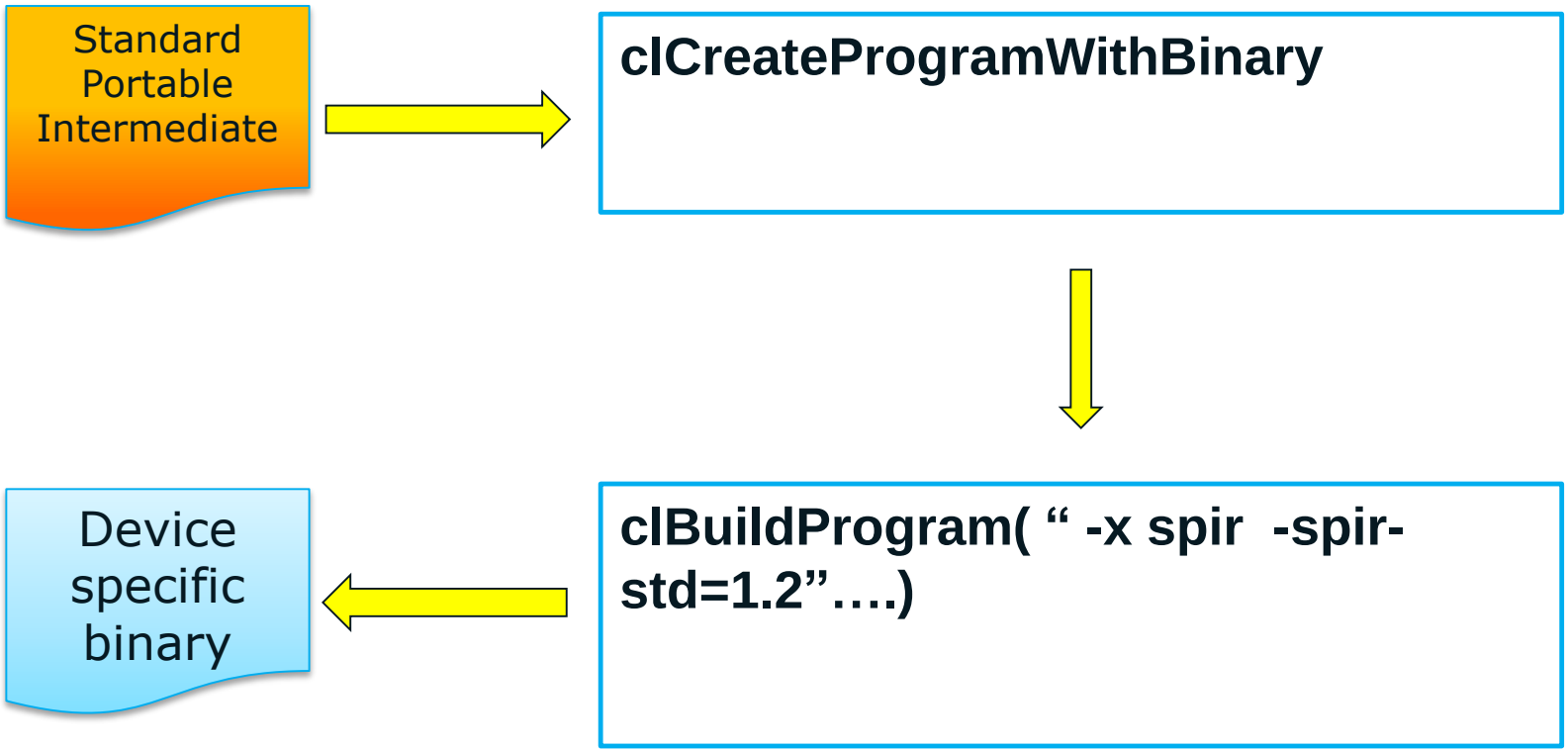
OpenCL: Binary compilation flow



ISV ships vendor-specific binary

- Proliferation: devices, driver revisions, vendors
- Market-lagging: target *shipped* products

Sample SPIR consumption flow



SPIR Goals

Reduce ISV pain

- Avoid IP exposure: do not ship source
- Manage device/driver/vendor proliferation
- Avoid market lag

Open a door for innovation on top of OpenCL™ standard

- Support 3rd party compilers
- Allow additional programming languages to target OpenCL runtimes

LLVM IR

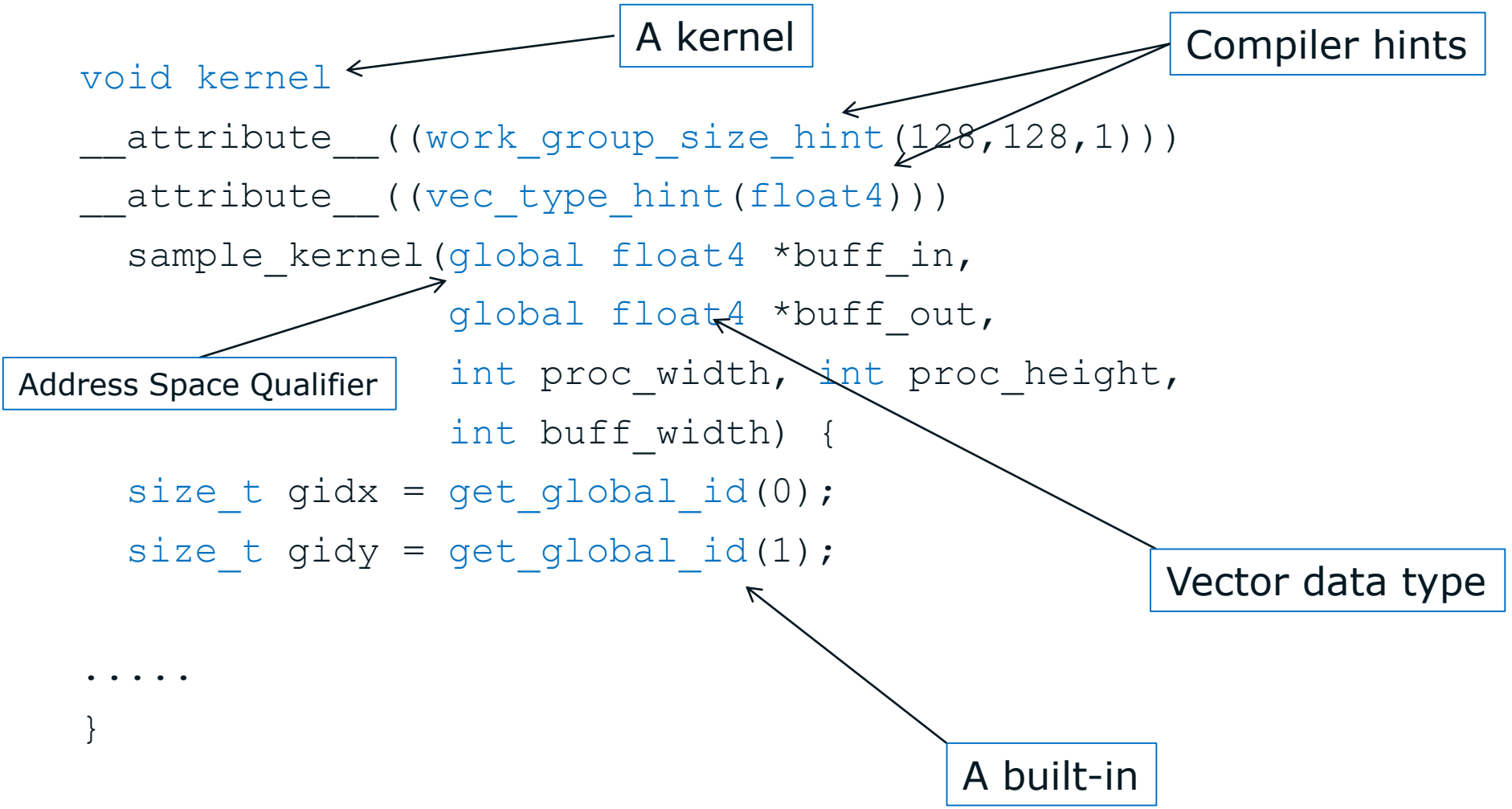
- Static Single Assignment (SSA) based representation
- Strong typed, low-level operations
- capable of representing high-level languages cleanly
- used throughout all phases of LLVM mid-end optimizations

```
define i32 @mul_add(i32 %x, i32 %y, i32 %z) {
entry:
  %tmp = mul i32 %x, %y
  %tmp2 = add i32 %tmp, %z
  ret i32 %tmp2
}
```

A Closer Look at SPIR

- Layered on top of LLVM IR
  - A subset of LLVM IR
    - Example: LLVM *i3* data type is illegal by SPIR specification
  - SPIR related changes are available at llvm.org since llvm 3.0
    - New SPIR32 and SPIR 64 targets
    - New SPIR function and SPIR kernel calling conventions
- Standardizes the LLVM representation of OpenCL™ programs
  - Data types, built-ins name mangling, ABI, and so on…
  - OpenCL-specific information
    - Utilizes LLVM metadata infrastructure
    - Examples: OpenCL standard version, SPIR version, compiler options
- A SPIR version is associated with an LLVM version

Example: a cl program anatomy




```
void kernel
__attribute__((work_group_size_hint(128,128,1)))
__attribute__((vec_type_hint(float4)))
  sample_kernel(global float4 *buff_in,
                global float4 *buff_out,
                int proc_width, int proc_height,
                int buff_width) {
  size_t gidx = get_global_id(0);
  size_t gidy = get_global_id(1);

.....
}
```

Example: the SPIR binary anatomy

```
target datalayout = ...
target triple = "spir-unknown-unknown"
define spir_kernel
void
@sample_kernel(<4 x float> addrspace(1)* nocapture %buff_in,
               <4 x float> addrspace(1)* nocapture %buff_out,
                i32 %proc_width, i32 %proc_height,
                i32 %buff_width) nounwind
{
entry:
%call = tail call spir_func i32 @_Z13get_global_idj(i32 0) nounwind readnone
. . .
ret void
}
```

SPIR Target Information

A Kernel CC

built-ins name mangling

A built-in / user function CC

OpenCL specific metadata

```
!1 = metadata !{metadata !"work_group_size_hint", i32 128, i32 128, i32 1}
!2 = metadata !{metadata !"vec_type_hint", <4 x float> undef, i32 0}
...
```

SPIR Usage Advantages

Standardizes a portable binary format

- Brings functional portability to OpenCL™ programs at binary level

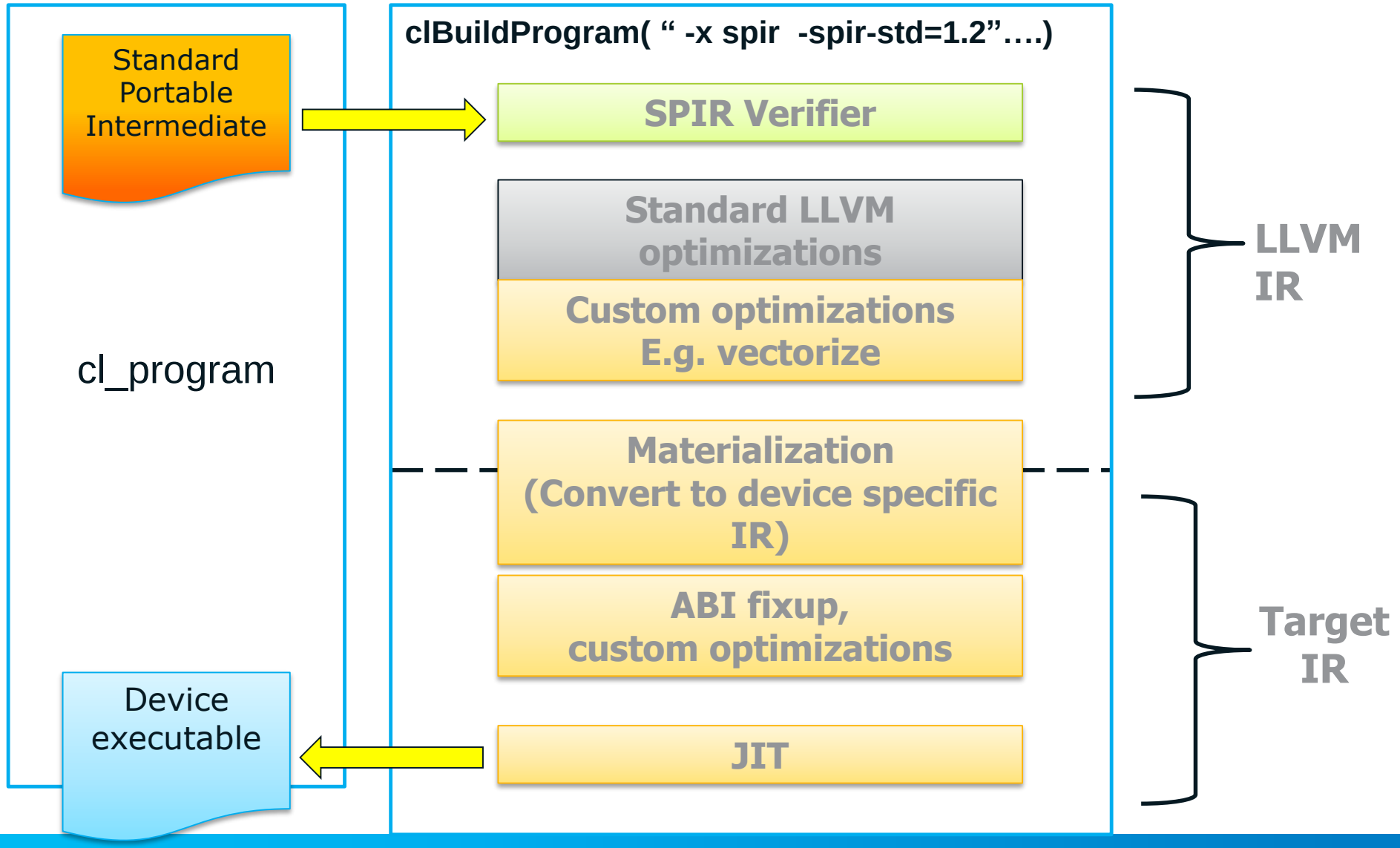
Enable additional high-level languages to target OpenCL implementations

- Simplifies cross-platform enablement
- An industry-open standard

Layered on top of LLVM

- Open source with permissive license
- Well-known & well-documented compiler infrastructure
- Clang includes most of the changes to support SPIR generation

Sample SPIR flow: Room for optimizations



Shevlin Park as a SPIR Generator

- A C++ AMP implementation in Clang/LLVM using OpenCL™ standard
  - Presented at LLVM November 2012 developer conference
    - By Dillon Sharlet from Intel
  - http://llvm.org/devmtg/2012-11/Sharlet-ShevlinPark.pdf
- Translate C++ AMP kernel code to OpenCL "C" programs
- Would rather target SPIR instead of generating OpenCL "C"
  - Examples:
    - Save redundant unstructured to structured control flow hassle
    - Better code quality due to less reliance on runtime optimizations
    - More efficient device code compilation due to transferring compilation cost from runtime to compile time

SPIR 1.2 support by Intel

Intel® SDK for OpenCL* Applications XE 2013 introduces SPIR 1.2 as a preview feature

- Download link: http://software.intel.com/en-us/vcsource/tools/opencl-sdk-xe
- Announcement link: http://software.intel.com/en-us/forums/topic/475429

Go Ahead and give it a try ☺

Thank you

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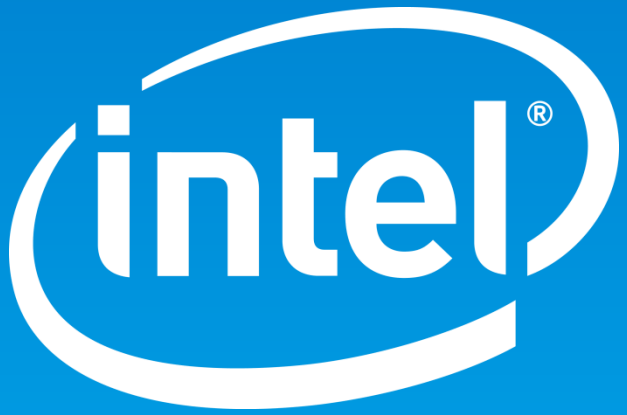
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