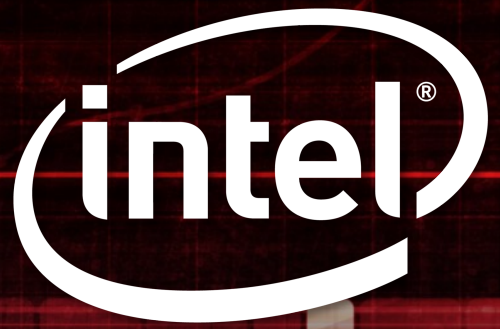


Heterogeneous parallel programming with open standards using oneAPI and Data Parallel C++

Jeff Hammond
Intel

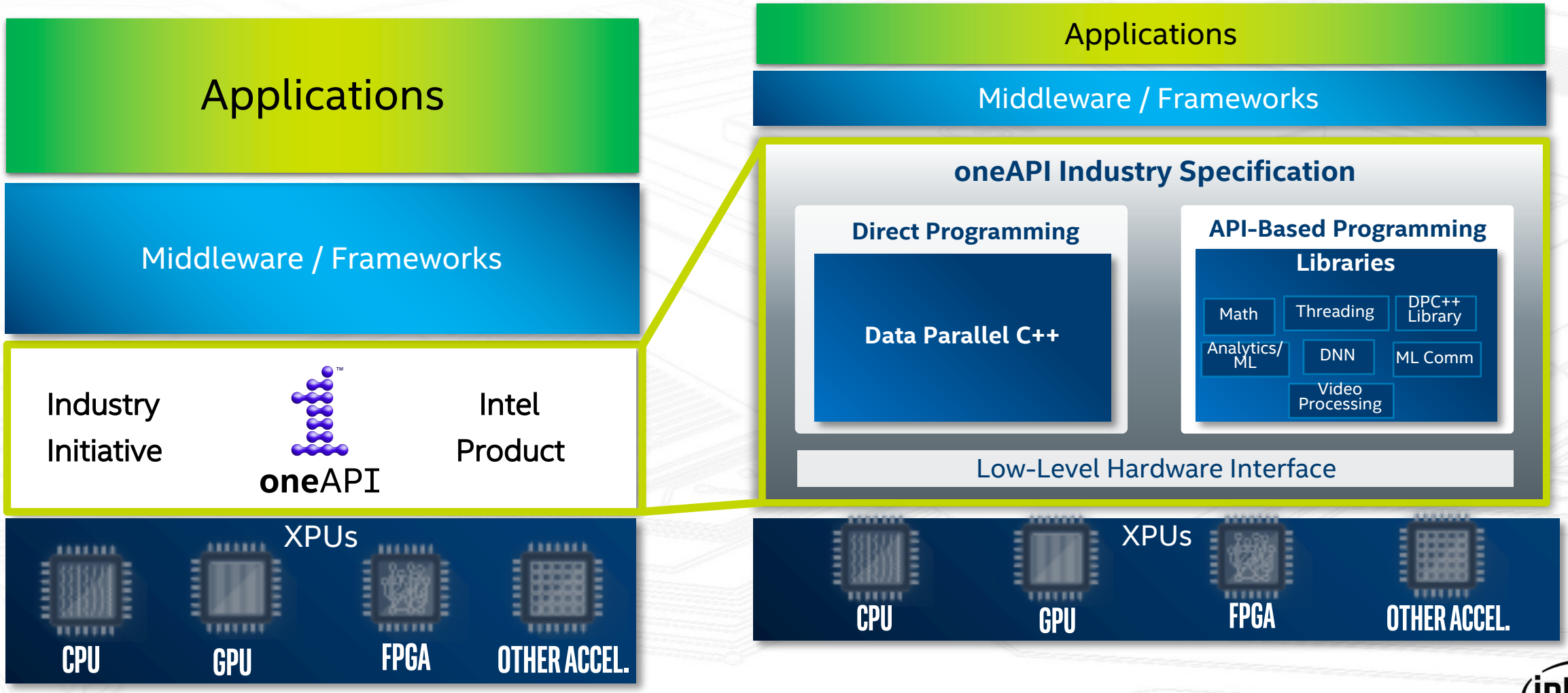
Problem Statement

Diversity and complexity in computer architecture has been growing continuously since the year 2000 and there is no indication that programming is going to get any easier any time soon.

Even with architectural families, there are differences in how vendors implement processors, both with software and hardware.

While performance tuning is architecture-specific and often microarchitecture-specific, programmers are most productive when tuning working code, as opposed to porting code then tuning it.

INTEL ONEAPI



Visit oneapi.com for more details

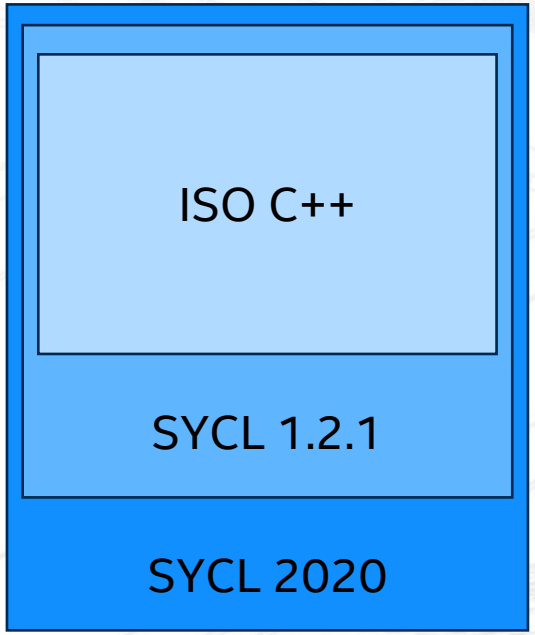
Khronos SYCL 2020 and Data Parallel C++

Intel DPC++ is a Clang-based open-source compiler for ISO C++ and Khronos SYCL.

The SYCL 2020 provisional specification includes a number of important improvements to SYCL 1.2.1:

- Unified Shared Memory (USM)
- Reductions
- Subgroups
- In-order queues

Intel continues to work with the SYCL community to bring additional language features into the standard.



Intel's extensions – both the documentation and the implementation source code - are currently available on GitHub: https://github.com/intel/llvm/

Why SYCL?

OpenCL has a well-defined, portable execution model, but is considered too verbose by application programmers and lacks good C++ support.

SYCL is based on purely modern C++, which allows it to support heterogeneous accelerators within a single-source model.

SYCL parallelism is similar to TBB and the C++ STL while giving users explicit control over hardware resources when they want it.

Why SYCL?

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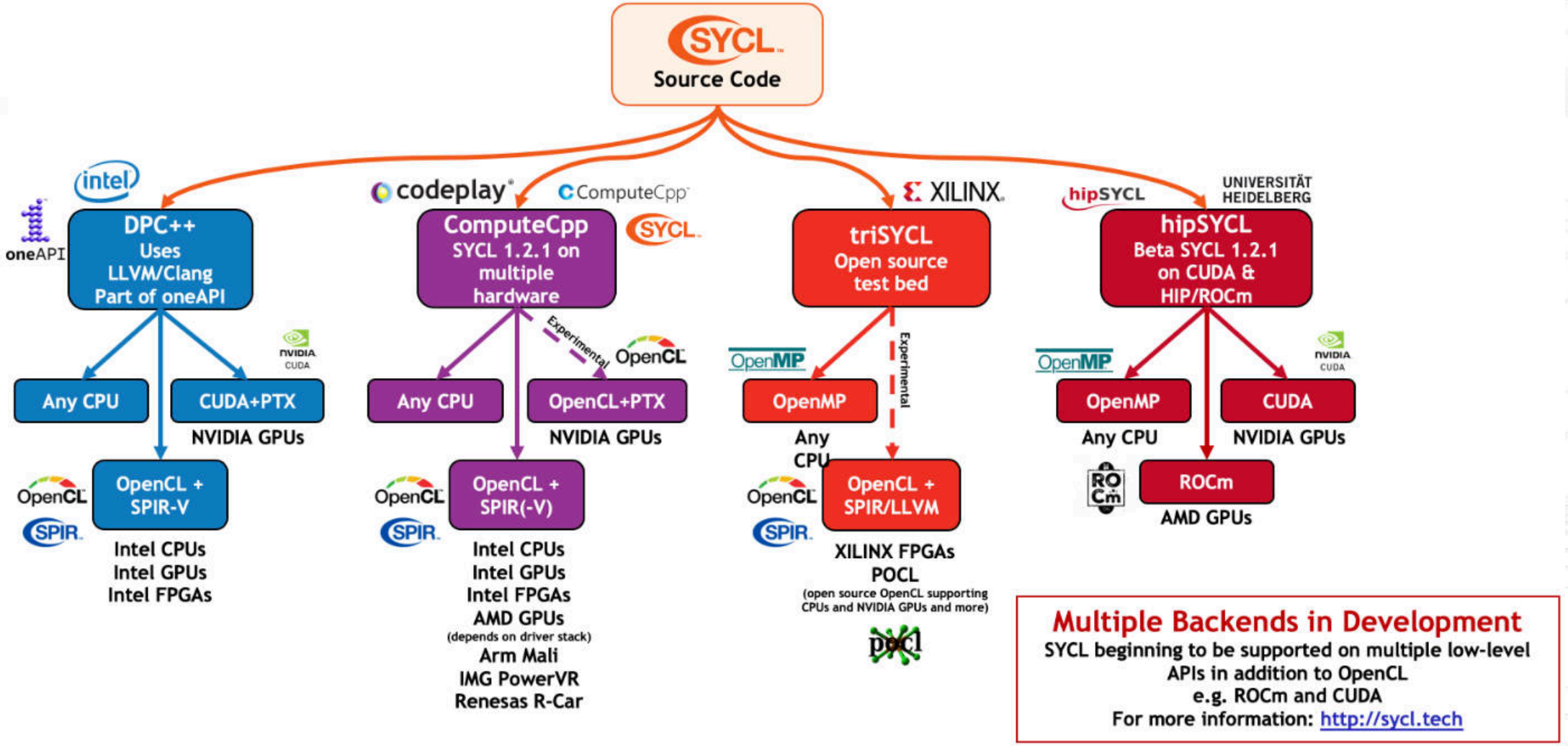
SYCL parallelism is similar to TBB and the C++ STL while giving users explicit control over hardware resources when they want it.

SYCL is the first standard programming model designed for heterogeneous programming with modern C++

SYCL Ecosystem as of June 2020



https://www.khronos.org/assets/uploads/apis/2020-05-sycl-landing-page-02_2.jpg

intel

SYCL Platform Portability Measurements

- Authors:
  Tom Deakin and Simon McIntosh-Smith
  of the University of Bristol
- Paper:
  https://dl.acm.org/doi/abs/10.1145/3388333.3388643
- Video:
  https://www.youtube.com/watch?v=5W6SsreZ3ew
- Code: https://github.com/UoB-HPC/BabelStream

The low SYCL/OpenCL performance on Intel Xeon processors is a known implementation issue in Intel OpenCL. It is not a fundamental limitation and will be fixed in the future.

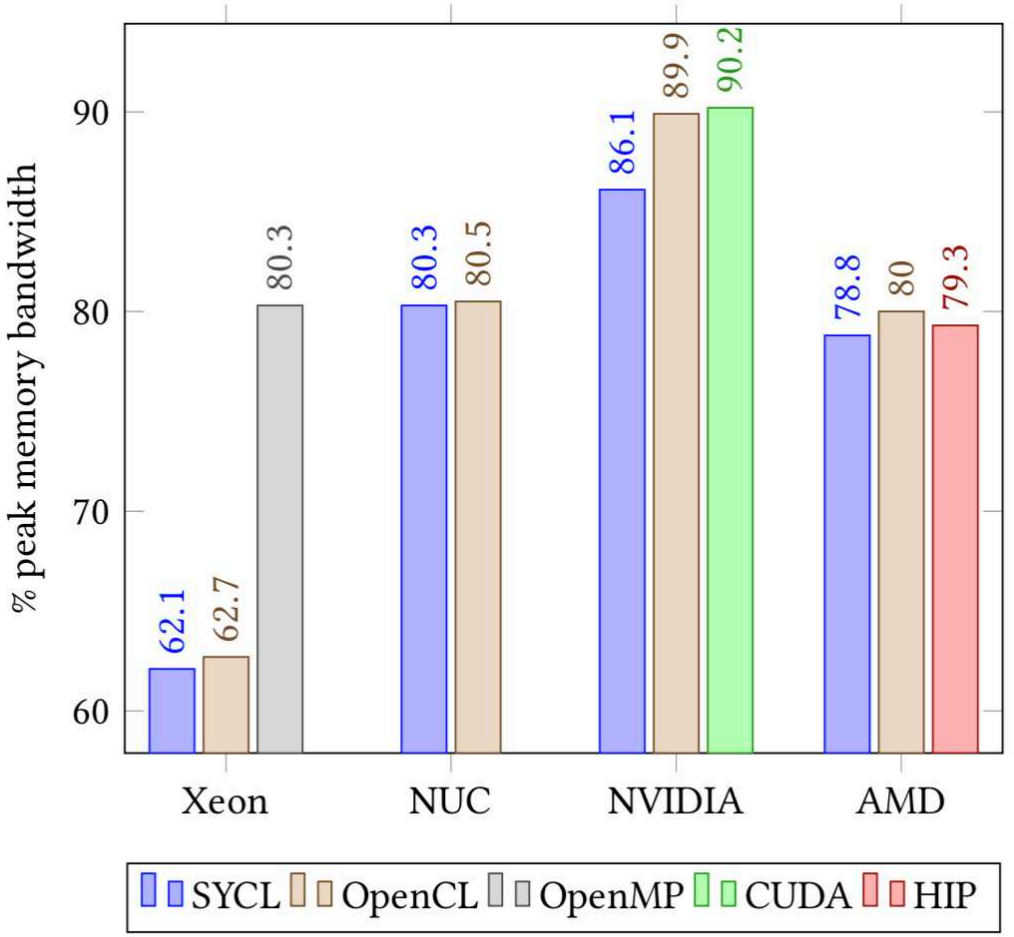


Figure 1: BabelStream Triad results

SYCL Platform Portability Measurements

- Authors:
  Brian Homerding and John Tramm of Argonne National Laboratory
- Paper:
  https://dl.acm.org/doi/abs/10.1145/3388333.3388660
- Video:
  https://www.youtube.com/watch?v=-xzuFLZ64W0
- Code:
  https://github.com/homerdin/RAJAPerf/tree/sycl

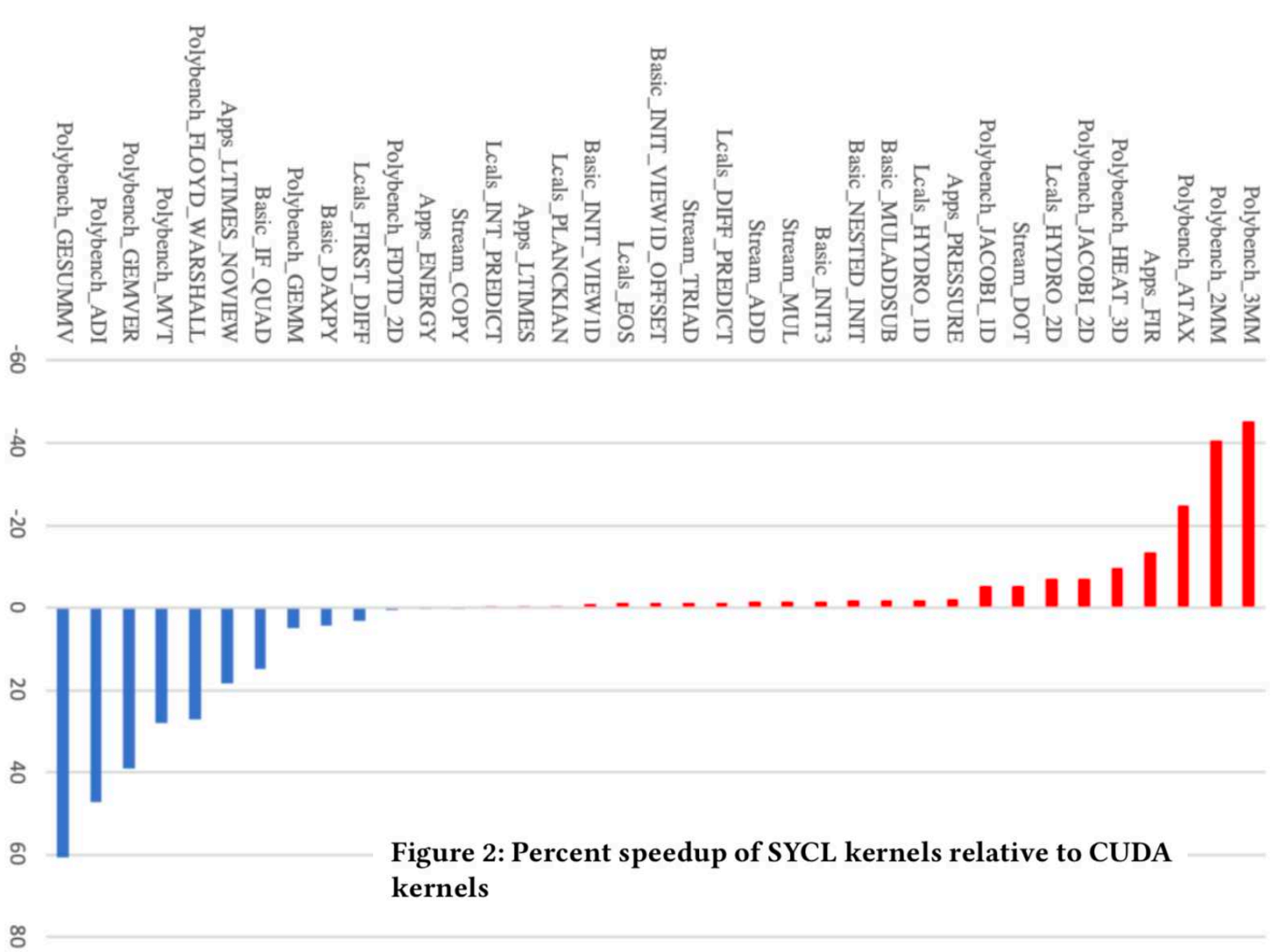


Figure 2: Percent speedup of SYCL kernels relative to CUDA kernels

PROGRAMMING IS ALSO ABOUT THE CODE YOU DON'T WRITE!

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BUSINESS INSIDER By Megan Rose Dickey | Business Insider – Wed, Jan 16, 2013 8:57 AM EST

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oneAPI Libraries

- oneDPL: C++ standard library functions, including GPU parallel STL
- oneMKL: math library for Intel CPU and Intel GPU
  - CodePlay contributed CUBLAS support
- oneDNN: Deep Neural Network Library (was MKL-DNN)
  - Supports a variety of non-Intel processors already
- oneCCL: Collective Communication Library (was MLSL)
- oneDAL: Data Analytics Library (was DAAL)
- oneVPL: Video Processing Library

LEARN MORE ABOUT ONEAPI

- oneAPI specifications https://www.oneapi.com
- Intel oneAPI implementation https://software.intel.com/en-us/oneapi
  - Apt, Yum, Zypper installation on Linux
  - Docker
  - Traditional online and offline binary installers for Linux and Windows
  - DevCloud: https://intelsoftwaresites.secure.force.com/devcloud/oneapi
    - DevCloud includes CPU, GPU and FPGA hardware…
- Tutorials and sample code
  - https://github.com/jeffhammond/dpcpp-tutorial
  - https://github.com/alcf-perfengr/sycltrain
  - https://github.com/oneapi-src/oneAPI-samples
  - https://software.intel.com/content/www/us/en/develop/articles/brightskies-experience-using-oneapi-for-reverse-time-migration.html


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