oneAPI

Cross-Architecture Programming for Accelerated Compute, Freedom of Choice for Hardware

Intel® oneAPI: A Unified X-Architecture Programming Model

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Technical Consulting Engineer

intel

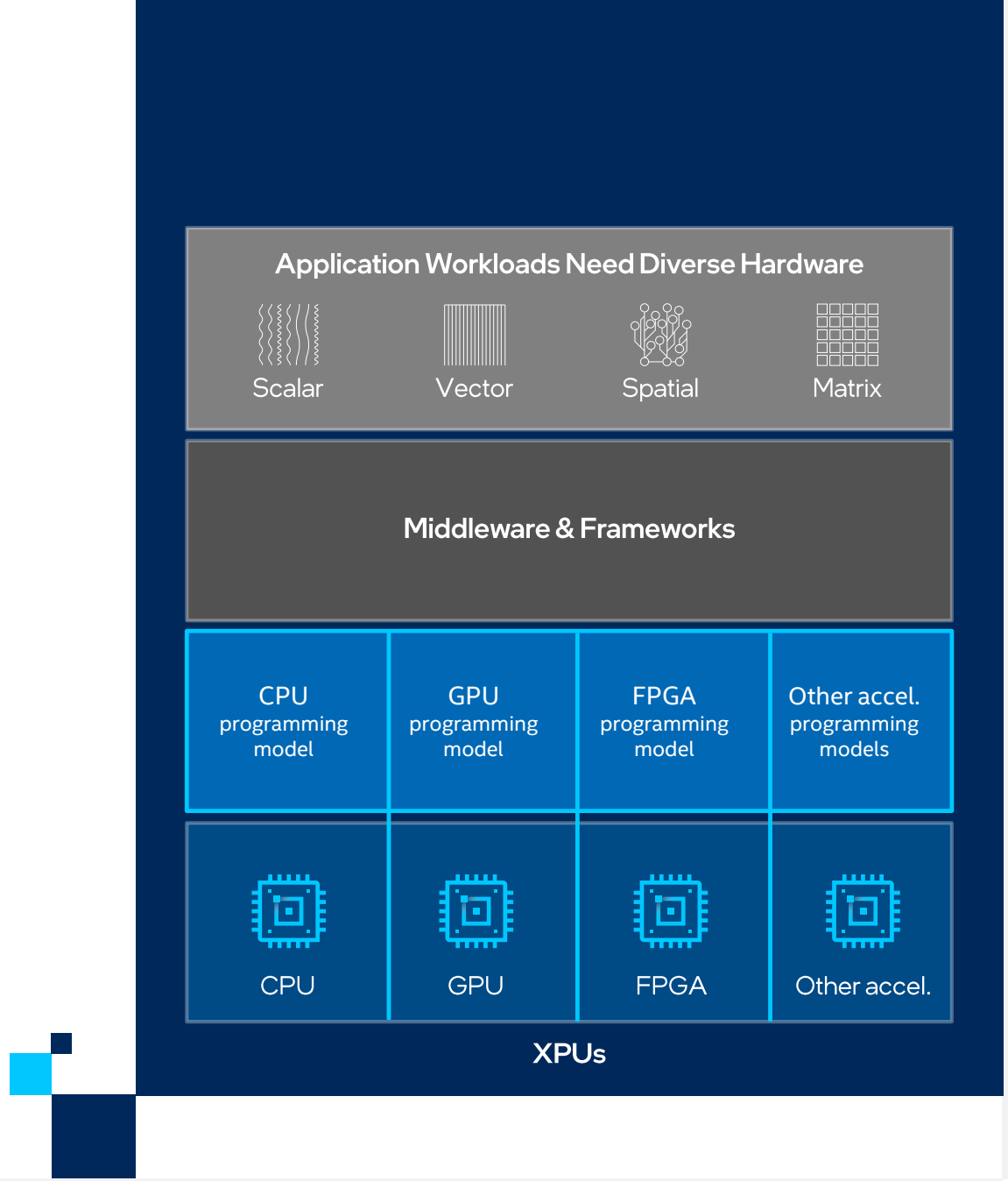
Programming Challenges
for Multiple Architectures

Growth in specialized workloads

Variety of data-centric hardware required

Separate programming models and toolchains for each architecture are required today

Software development complexity limits freedom of architectural choice



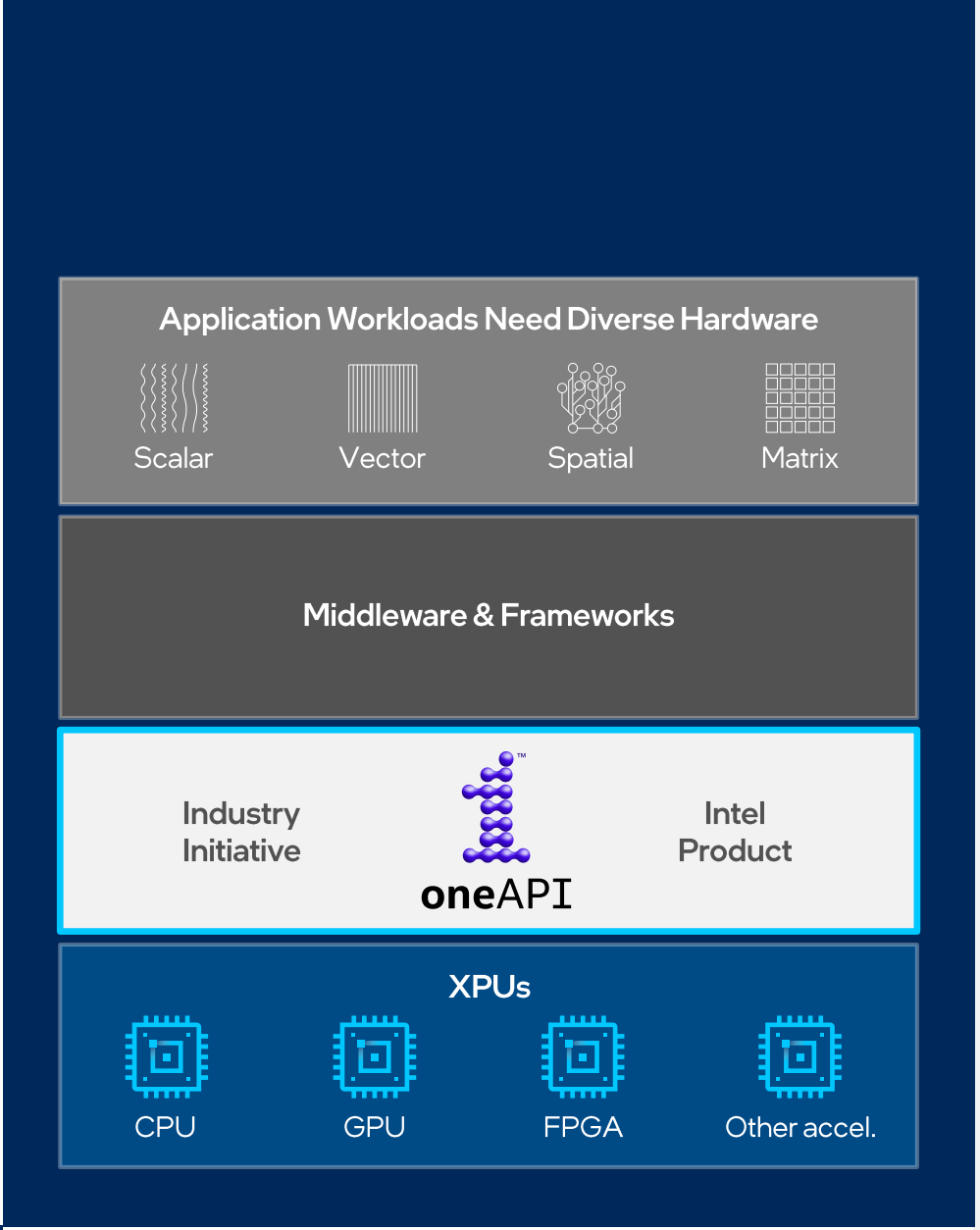
Introducing
oneAPI

Cross-architecture programming that delivers freedom to choose the best hardware

Based on industry standards and open specifications

Exposes cutting-edge performance features of latest hardware

Compatible with existing high-performance languages and programming models including C++, OpenMP, Fortran, and MPI



oneAPI Industry Initiative

Break the Chains of Proprietary Lock-in

A cross-architecture language based on C++ and SYCL standards

Powerful libraries designed for acceleration of domain-specific functions

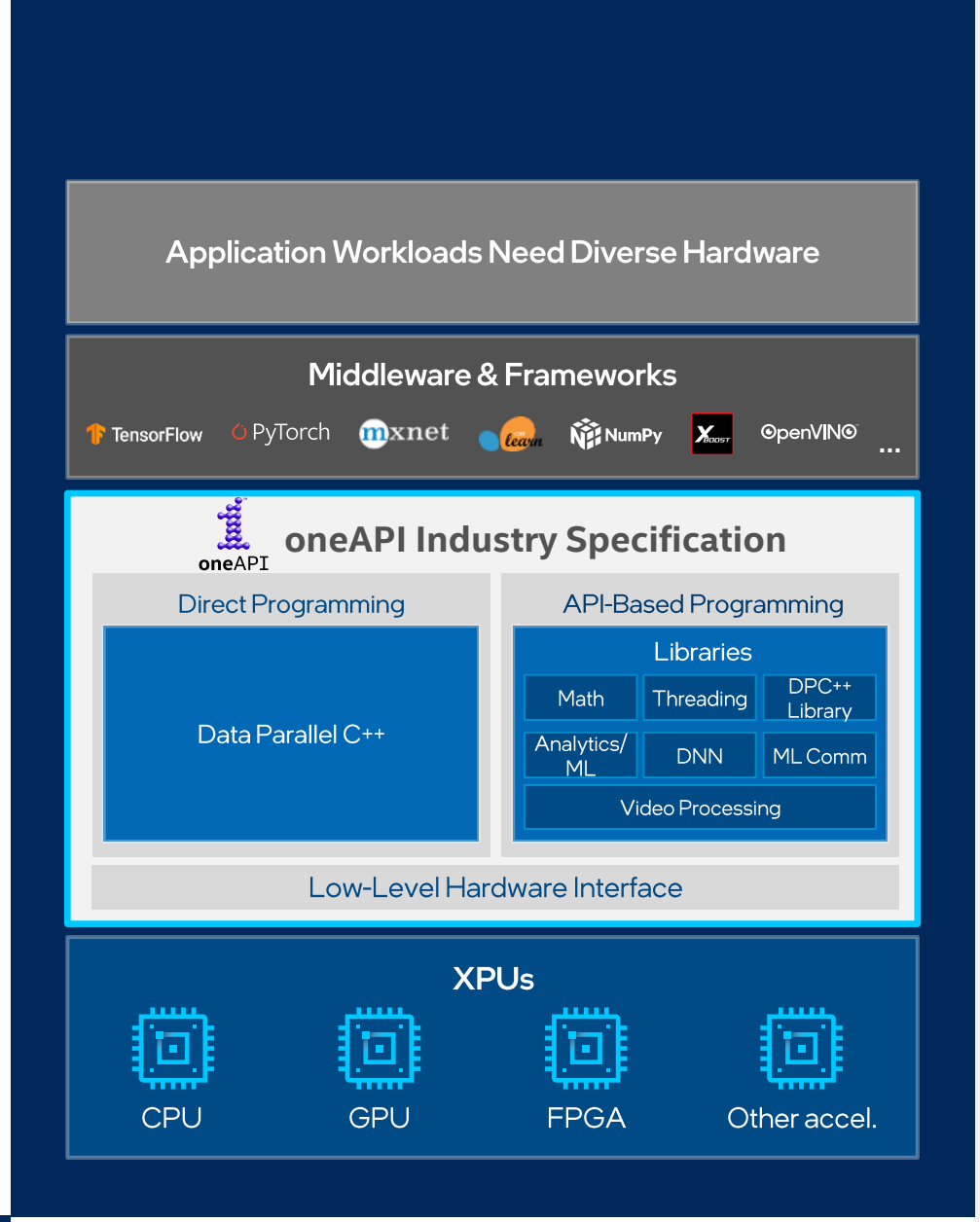
Low-level hardware abstraction layer

Open to promote community and industry collaboration

Enables code reuse across architectures and vendors

oneAPI

The productive, smart path to freedom for accelerated computing from the economic and technical burdens of proprietary programming models



Data Parallel C++

Standards-based, Cross-architecture Language
DPC++ = ISO C++ and Khronos SYCL

Parallelism, productivity and performance for CPUs and Accelerators

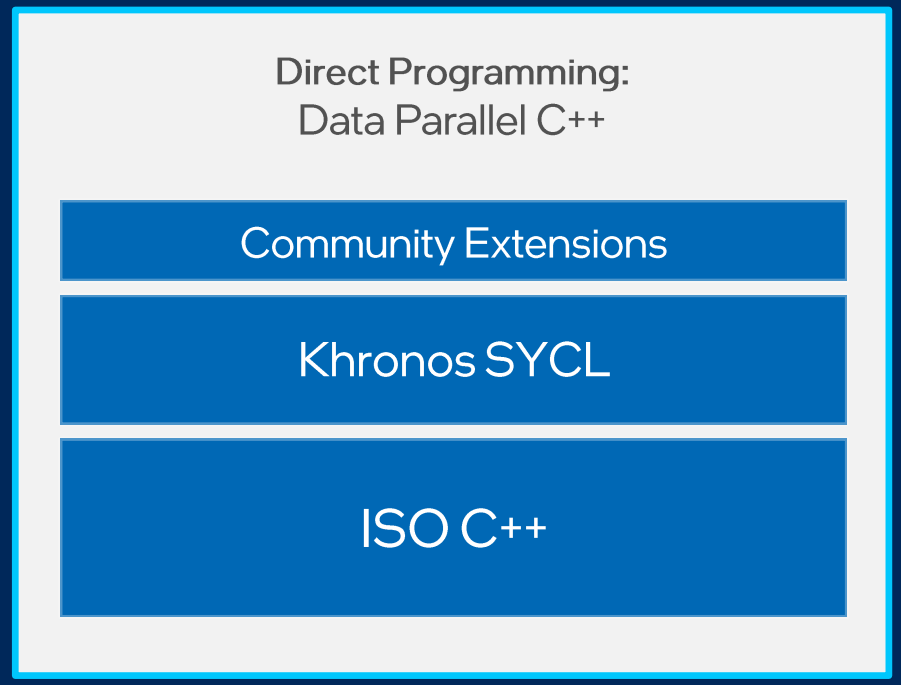
- Delivers accelerated computing by exposing hardware features
- Allows code reuse across hardware targets, while permitting custom tuning for specific accelerators
- Provides an open, cross-industry solution to single architecture proprietary lock-in

Based on C++ and SYCL

- Delivers C++ productivity benefits, using common, familiar C and C++ constructs
- Incorporates SYCL from the Khronos Group to support data parallelism and heterogeneous programming

Community Project to drive language enhancements

- Provides extensions to simplify data parallel programming
- Continues evolution through open and cooperative development

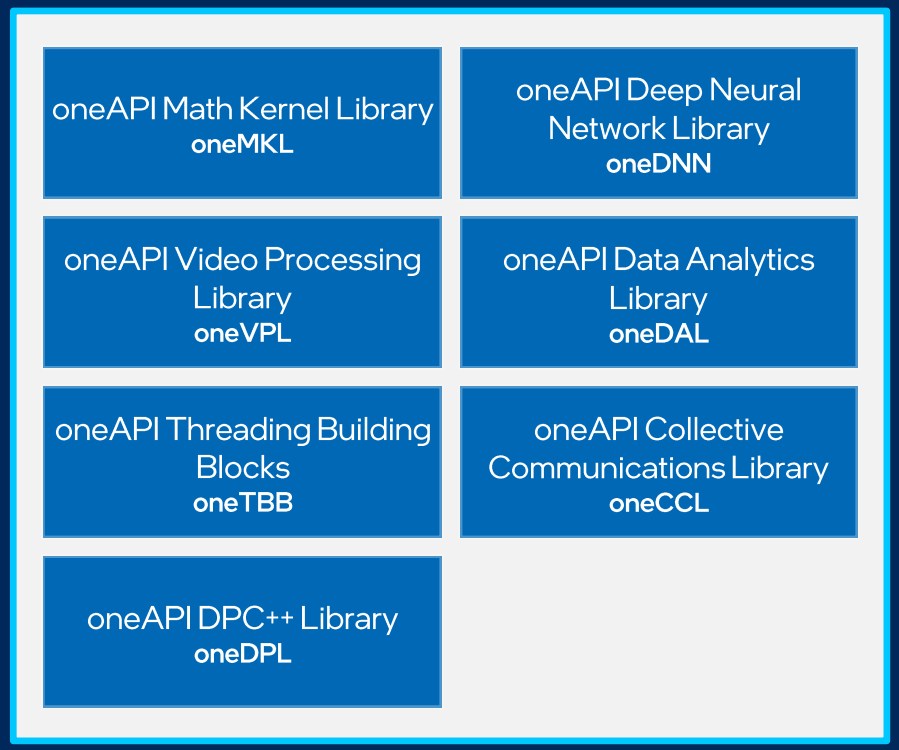


Apply your skills to the next innovation, not rewriting software for the next hardware platform

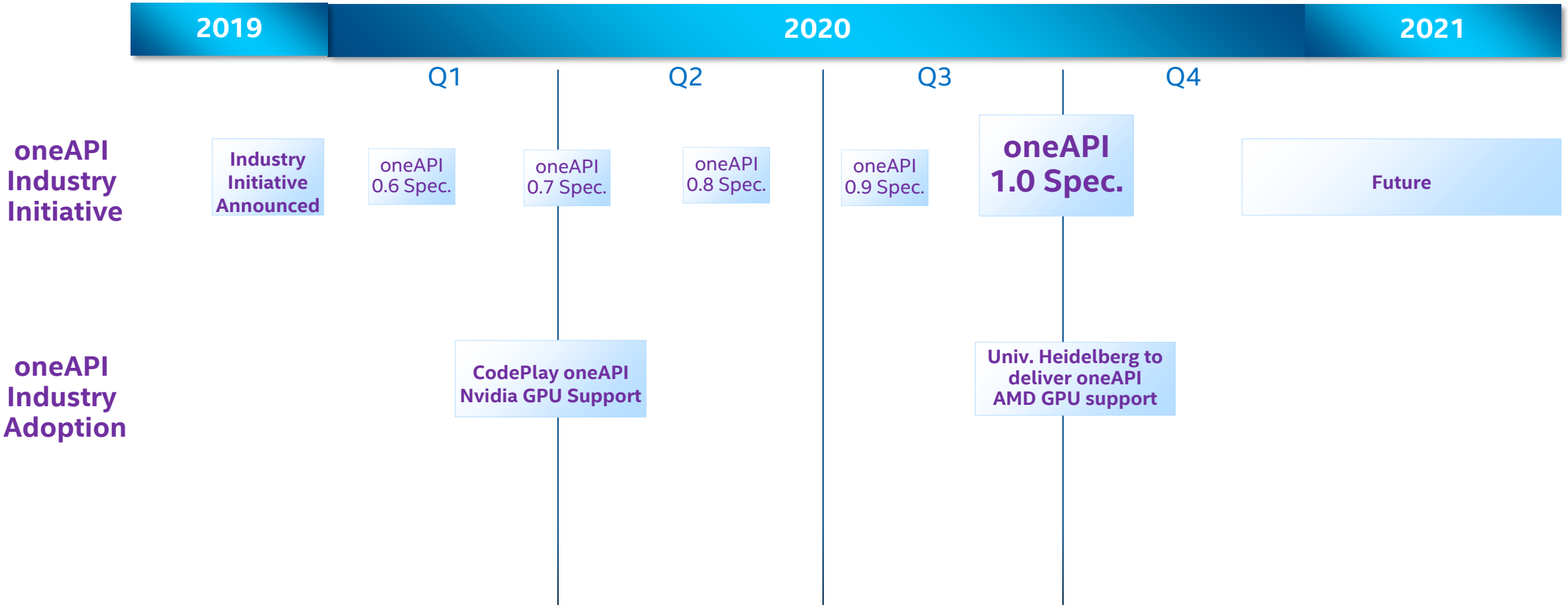
The open source and Intel DPC++/C++ compiler supports Intel CPUs, GPUs, and FPGAs.
Codeplay announced a DPC++ compiler that targets Nvidia GPUs.

Powerful oneAPI Libraries

- Designed for acceleration of key domain-specific functions
- Pre-optimized for each target platform for maximum performance



oneAPI Industry Initiative Progress



oneAPI

Ecosystem & News Updates 2020

More details: oneAPI.com

Sept. 30

Intel, Heidelberg University team up to bring Radeon GPU support to AI

Sept 28 - Intel oneAPI 1.0 Officially Released

June 30

SYCL 2020 Provisional Specification includes Contributions from Data Parallel C++

June 24 - TensorFlow support of oneAPI industry initiative

June 21

oneAPI Center of Excellence Announced with Univ. of Stockholm

oneAPI Specification is .85

May 15

oneAPI DPC++ Compiler Merges Its Initial CUDA Backend

oneAPI Specification: Intel Compute Runtime Adds oneAPI Level Zero Support

New Study Finds oneAPI Programming Saves Time & Money

A report from J.Gold Associates, oneAPI: Software Abstraction for a Heterogeneous Computing World, details enterprise and developer benefits of transitioning to oneAPI.

Key Takeaway: Moving to a cross-architecture model for application development can save an organization significant time and money—over 5 months and $300,000 each time a performance-sensitive application is moved to a new computing platform.

oneAPI Ecosystem Support

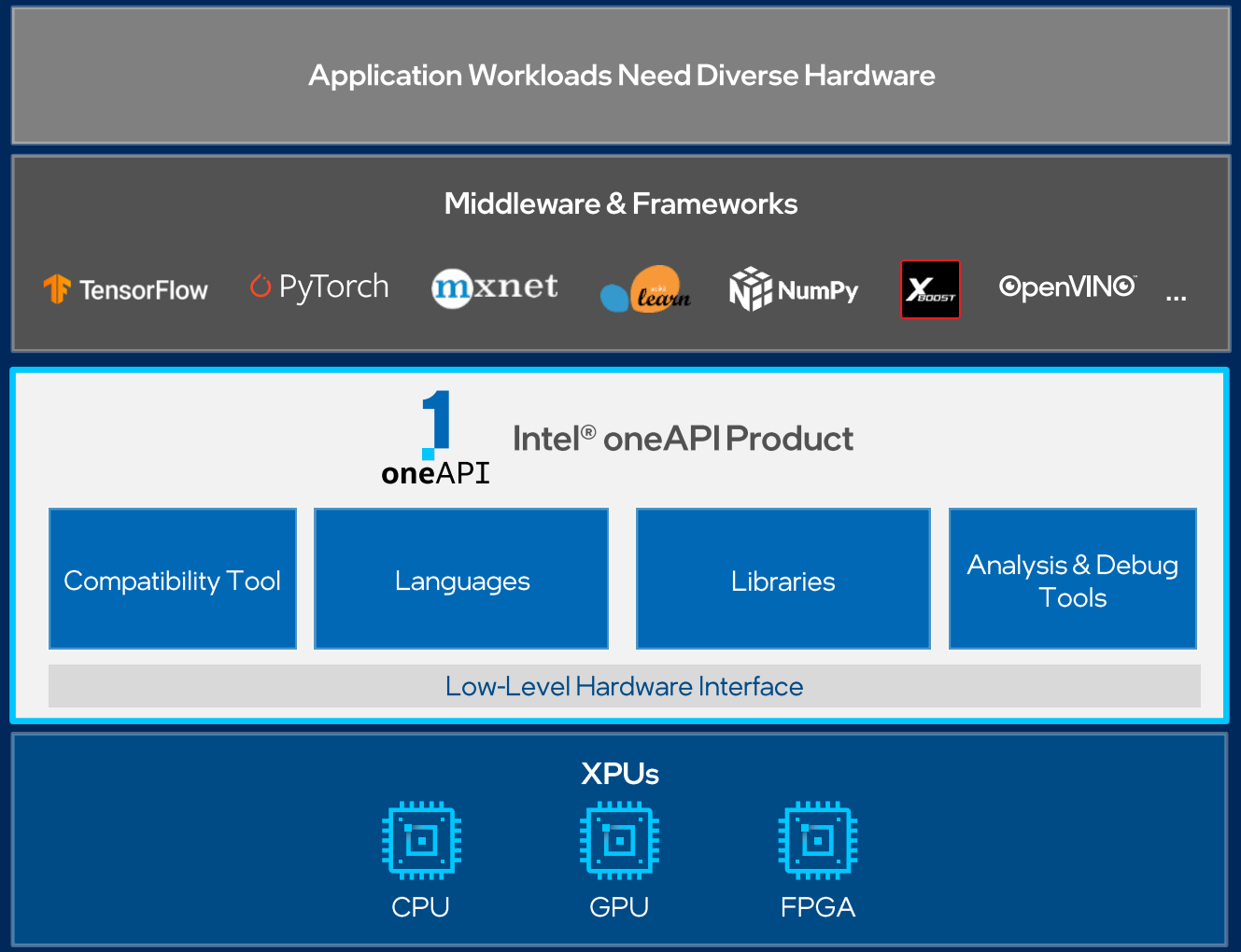
These organizations support the oneAPI initiative 'concept' for a single, unified programming model for cross-architecture development. It does not indicate any agreement to purchase or use of Intel's products.
*Other names and brands may be claimed as the property of others.

Intel® oneAPI Product

Built on Intel's Rich Heritage of CPU Tools Expanded to XPUs

A complete set of advanced compilers, libraries, and porting, analysis and debugger tools

- Accelerates compute by exploiting cutting-edge hardware features
- Interoperable with existing programming models and code bases (C++, Fortran, Python, OpenMP, etc.), developers can be confident that existing applications work seamlessly with oneAPI
- Eases transitions to new systems and accelerators using a single code base frees developers to invest more time on innovation



Available Now

Visit software.intel.com/oneapi for more details
Some capabilities may differ per architecture and custom-tuning will still be required. Other accelerators to be supported in the future.

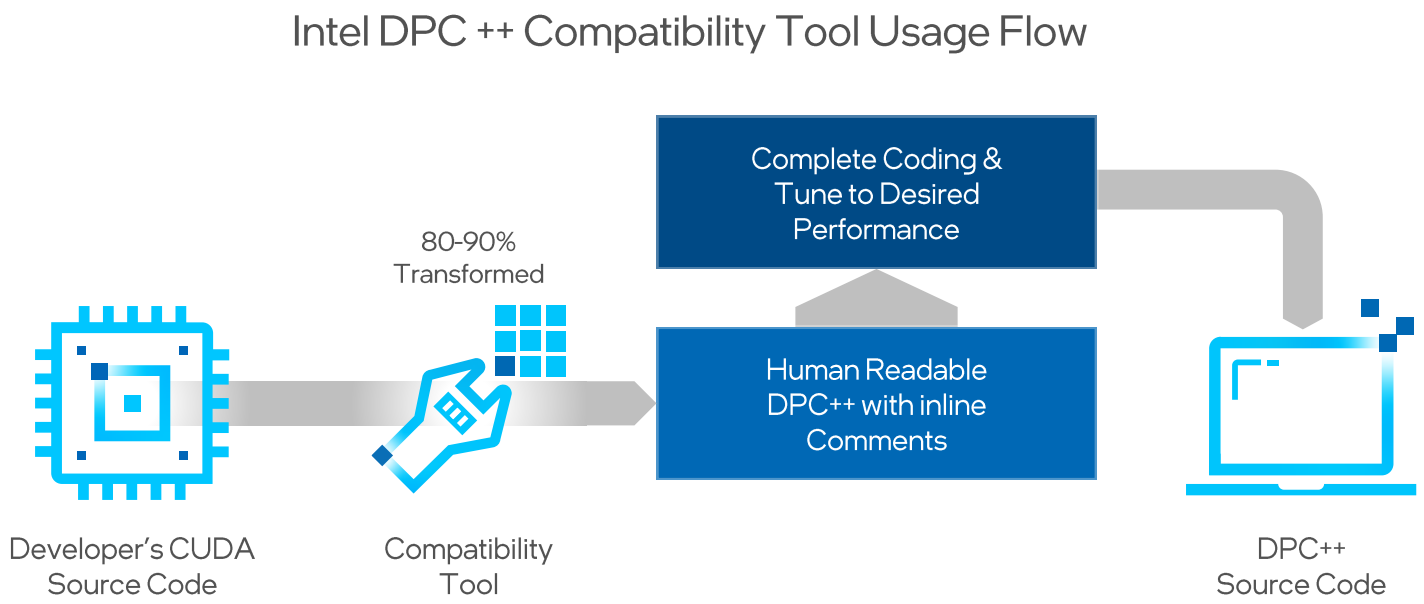
Intel® DPC++ Compatibility Tool

Minimizes Code Migration Time

Assists developers migrating code written in CUDA to DPC++ once, generating **human readable** code wherever possible

~80-90% of code typically migrates automatically

Inline comments are provided to help developers finish porting the application



Analysis & Debug Tools

Get More from Diverse Hardware

Design

Intel® Advisor

- Efficiently offload code to GPUs
- Optimize your CPU/GPU code for memory and compute
- Enable more vector parallelism and improve efficiency
- Add effective threading to unthreaded applications

Debug

Intel® Distribution for GDB

- Multiple accelerator support with CPU, GPU, FPGA emulation
- Enables deep, system-wide debug of Data Parallel C++ (DPC++), C, C++, and Fortran code

Tune

Intel® VTune™ Profiler

- Analyze DPC++
- Tune for GPU, CPU, and FPGA
- Optimize offload performance
- Supports DPC++, C, C++, Fortran, Python, Go, Java or a mix of languages

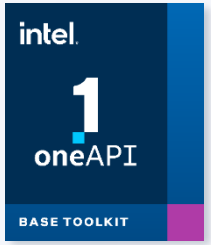
Use advanced tools to efficiently debug & profile code across all levels of abstraction.

Intel® oneAPI Toolkits

A complete set of proven developer tools expanded from CPU to XPU

Intel® oneAPI **Base** Toolkit

Native Code Developers



A core set of high-performance tools for building C++, Data Parallel C++ applications & oneAPI library-based applications

Add-on **Domain-specific** Toolkits

Specialized Workloads

Intel® oneAPI Tools for HPC

Deliver fast Fortran, OpenMP & MPI applications that scale

Intel® oneAPI Tools for IoT

Build efficient, reliable solutions that run at network's edge

Intel® oneAPI Rendering Toolkit

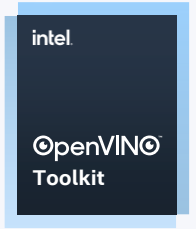
Create performant, high-fidelity visualization applications

Toolkits **powered by oneAPI**

Data Scientists & AI Developers

Intel® AI Analytics Toolkit

Accelerate machine learning & data science pipelines with optimized DL frameworks & high-performing Python libraries



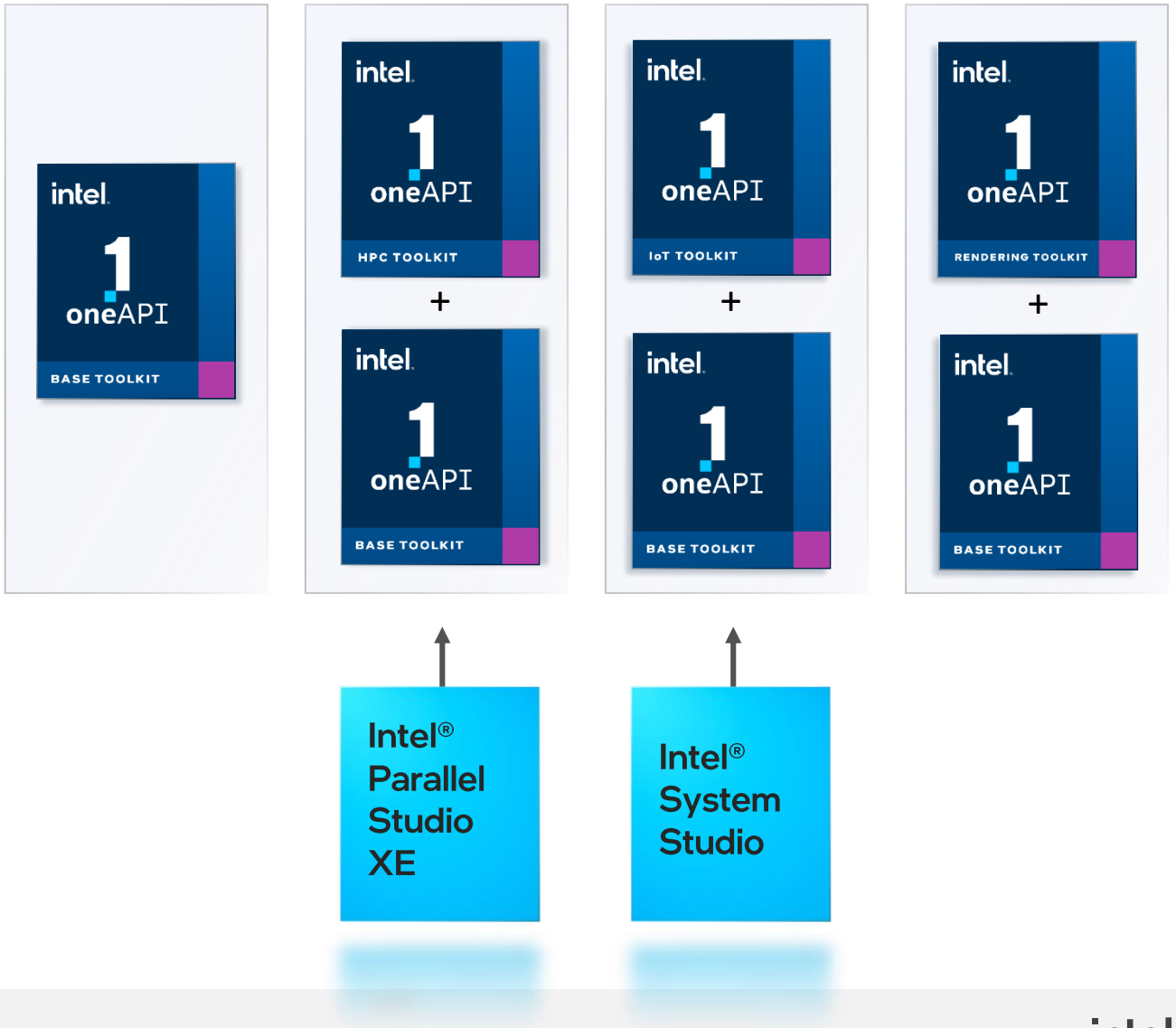
Intel® Distribution of OpenVINO™ Toolkit

Deploy high performance inference & applications from edge to cloud

Commercial oneAPI Toolkits Available

Next Generation of Commercial Intel® Software Development Products

- Worldwide support from Intel technical consulting engineers
- Prior commercial tool suites, Intel® Parallel Studio XE and Intel® System Studio, transition to oneAPI products

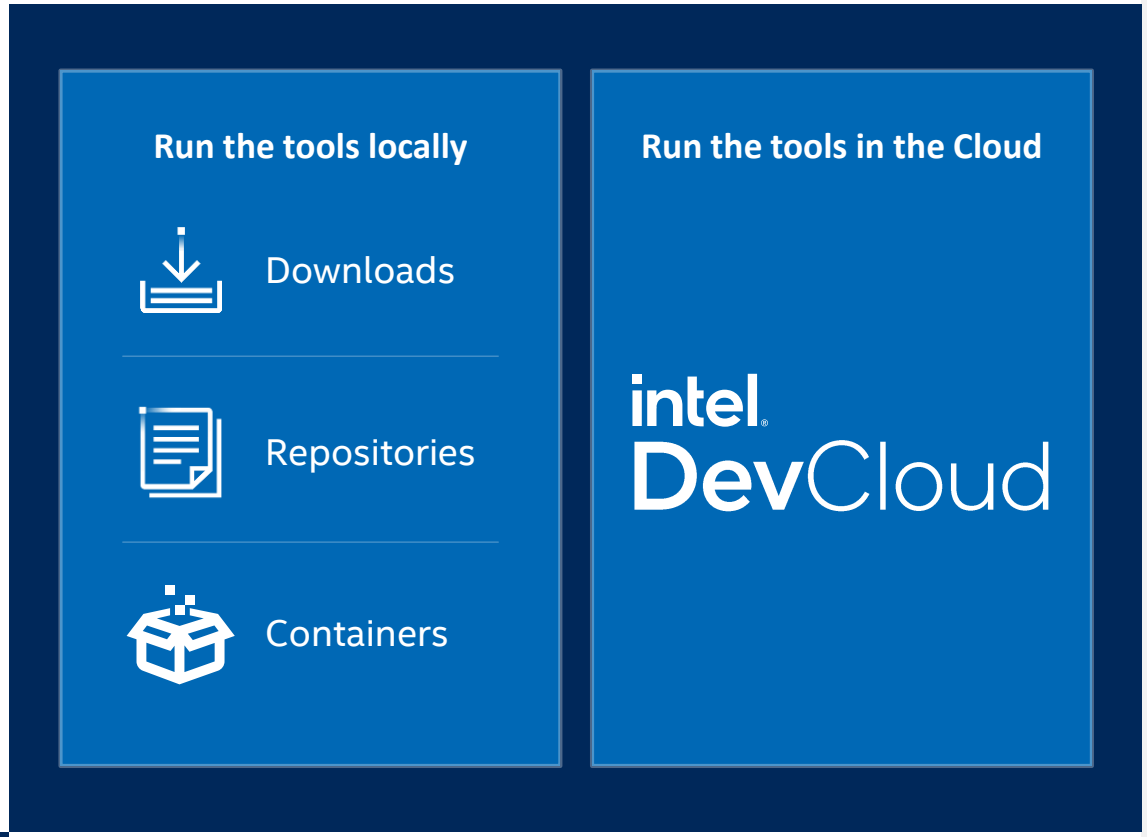


Intel® oneAPI Toolkits Free Availability

Get Started Quickly

Code Samples, Quick-start Guides, Webinars, Training

software.intel.com/oneapi



oneAPI

oneAPI Available on
Intel® DevCloud

A development sandbox to develop, test and run workloads across a range of Intel CPUs, GPUs, and FPGAs using Intel's oneAPI software.

Get Up & Running In Seconds!

software.intel.com/devcloud/oneapi

intel DevCloud

1 Minute to Code

No Hardware Acquisition

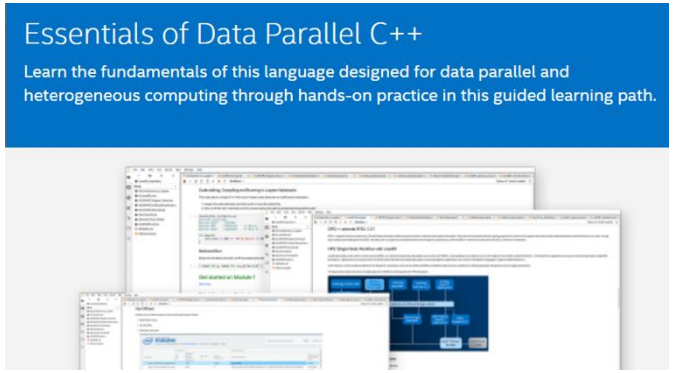
No Download, Install or Configuration

Easy Access to Samples & Tutorials

Support for Jupyter Notebooks, Visual Studio Code

Ecosystem Adoption & Support

Training

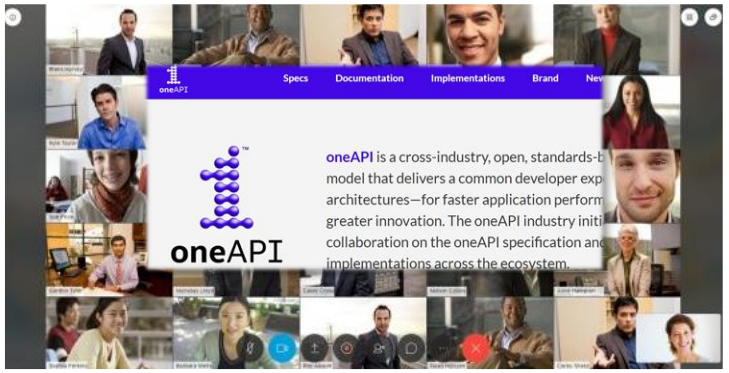


Online webinars & courses, developer guides, sample code

Academia

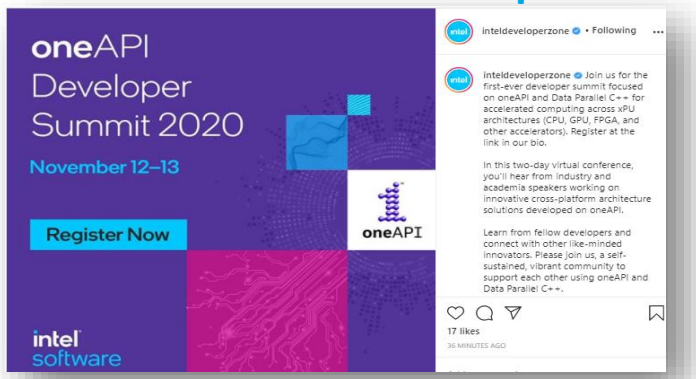
oneAPI Centers of Excellence: research, enabling code, curriculum, teaching

Community



oneAPI open specification, DevMesh innovators, community support forums

Summits & Workshops



Live & on-demand virtual workshops, community-led sessions

Industry Experts

Training by leading technical training companies worldwide

Intel® DevCloud

State-of-the-art software and hardware
Intel® oneAPI Toolkits + latest Intel® Xeon®processors, GPUs (integrated & discrete), FPGAs

oneAPI Resources

software.intel.com/oneapi

Learn and Get Started

- software.intel.com/oneapi
- Training
- Documentation
- Code Samples

Industry Initiative

- oneAPI.com
- oneAPI Industry Specification
- Open Source Implementations

Ecosystem

- Community Forums
- Academic Program
- Intel® DevMesh Innovator Projects

Summary

- Diverse workloads are driving the need for heterogeneous compute architectures, but each architecture has required separate programming models.
- oneAPI cross-architecture programming model provides freedom of choice. Apply your skills to the next innovation, not to rewriting software for the next hardware platform.
- Intel® oneAPI products take full advantage of accelerated compute by maximizing performance across Intel CPUs, GPUs, and FPGAs.
- Make development fast and efficient with a complete set of cross-architecture libraries and advanced tools that interoperate with existing performance programming models.

Details about Intel® oneAPI Toolkits

Intel® oneAPI Base Toolkit

Intel® oneAPI Base Toolkit

Accelerate Data-centric Workloads

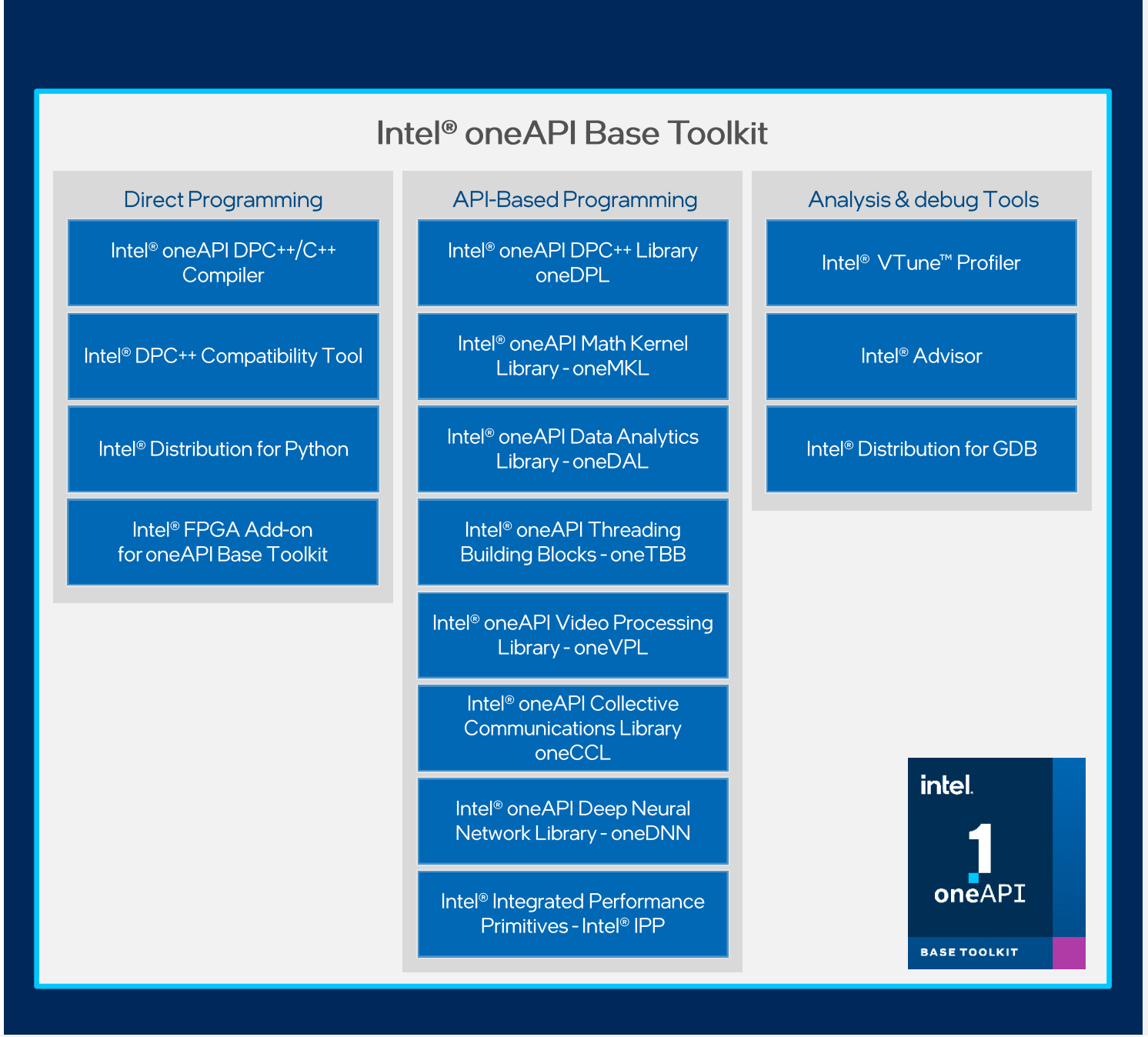
A core set of core tools and libraries for developing high-performance applications on Intel® CPUs, GPUs, and FPGAs.

Who Uses It?

- A broad range of developers across industries
- Add-on toolkit users since this is the base for all toolkits

Top Features/Benefits

- Data Parallel C++ compiler, library and analysis tools
- DPC++ Compatibility tool helps migrate existing code written in CUDA
- Python distribution includes accelerated scikit-learn, NumPy, SciPy libraries
- Optimized performance libraries for threading, math, data analytics, deep learning, and video/image/signal processing



Learn More: intel.com/oneAPI-BaseKit

Intel® oneAPI DPC++/C++ Compiler

Parallel Programming Productivity & Performance

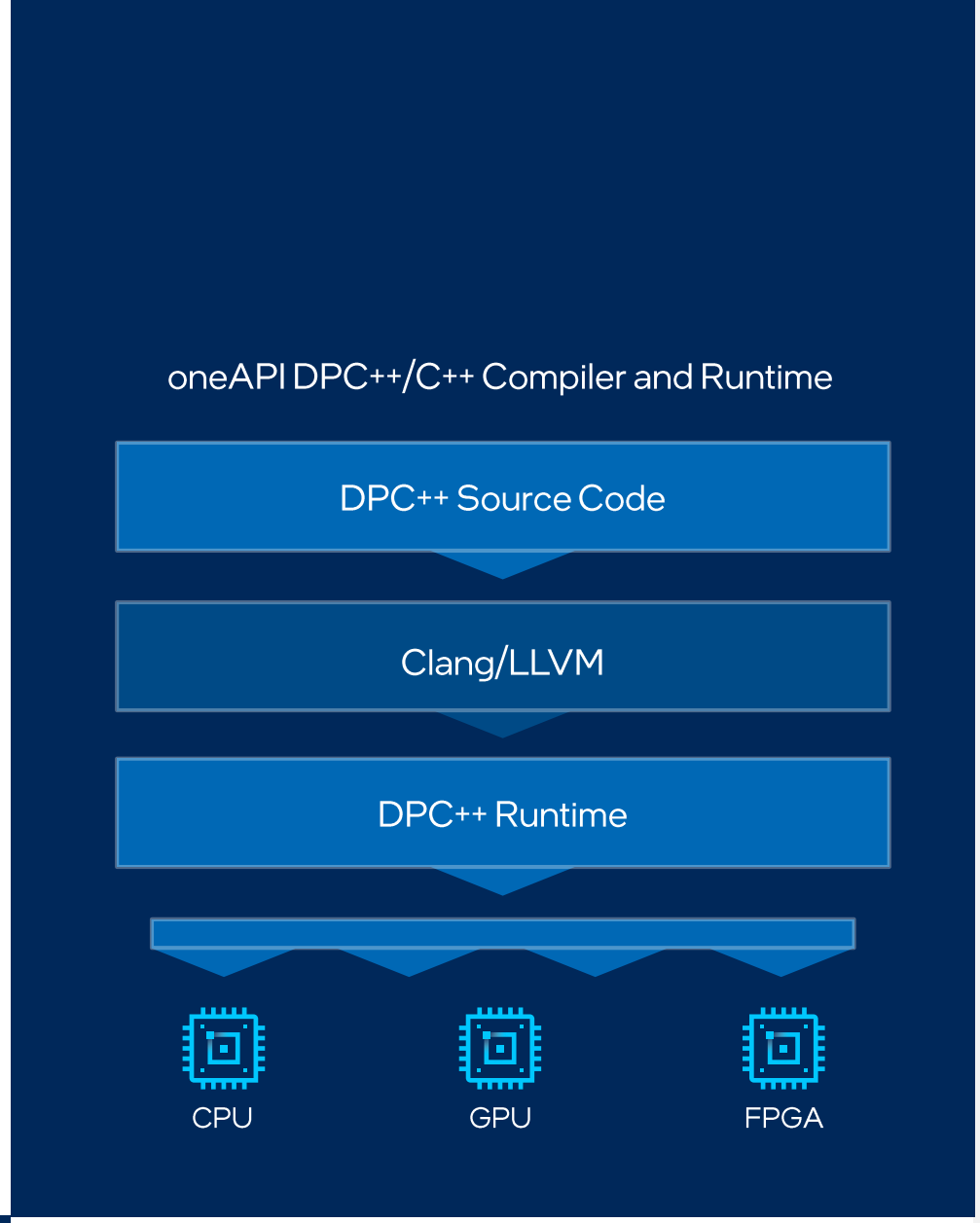
Compiler to deliver uncompromised parallel programming productivity and performance across CPUs and accelerators

- Allows code reuse across hardware targets, while permitting custom tuning for a specific accelerator
- Open, cross-industry alternative to single architecture proprietary language

DPC++ is based on ISO C++ and Khronos SYCL

- Delivers C++ productivity benefits, using common and familiar C and C++ constructs
- Incorporates SYCL from The Khronos Group to support data parallelism and heterogeneous programming

Builds upon Intel's decades of experience in architecture and high-performance compilers



There will still be a need to tune for each architecture.

Intel® oneAPI DPC++ Library

Accelerate DPC++ Kernels on Intel CPUs, GPUs & FPGAs

Optimized C++ Standard Algorithms

Contains 75 parallelized C++17 algorithms and utilities for efficient application development and deployment on a variety of hardware.

Based on parallel libraries that C++ developers are already familiar with

Incorporates popular libraries Parallel STL and Boost. Compute for easier developer adoption.

Integrated with Intel® DPC++ Compatibility Tool

Complements all oneAPI DPC++ components to simplify migration of developers' CUDA* code to DPC++ code.

Intel® oneAPI Deep Neural Network Library

Deliver High Performance Deep Learning

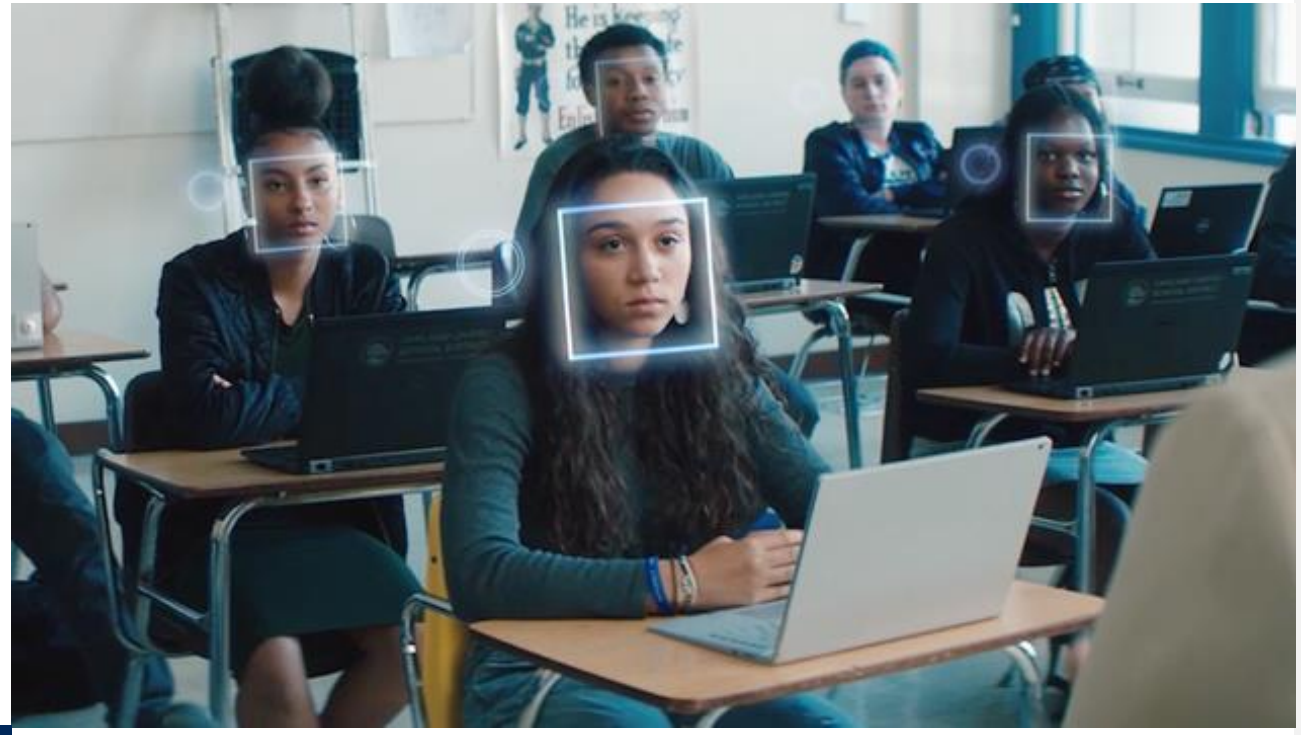
Helps developers create high performance deep learning frameworks

Abstracts out instruction set & other complexities of performance optimizations

Same API for both Intel CPUs and GPUs, use the best technology for the job

Supports Linux, Windows

Open sourced for community contributions



Intel® oneAPI Video Processing Library

Boost Media Performance

Boost media and video application performance with hardware-accelerated codecs and programmable graphics on Intel CPUs and Intel GPUs

Simple API that works the same on CPU and GPU

Using the API, developers have full control over codec visual quality and performance

Intel® oneAPI Collective Communications Library

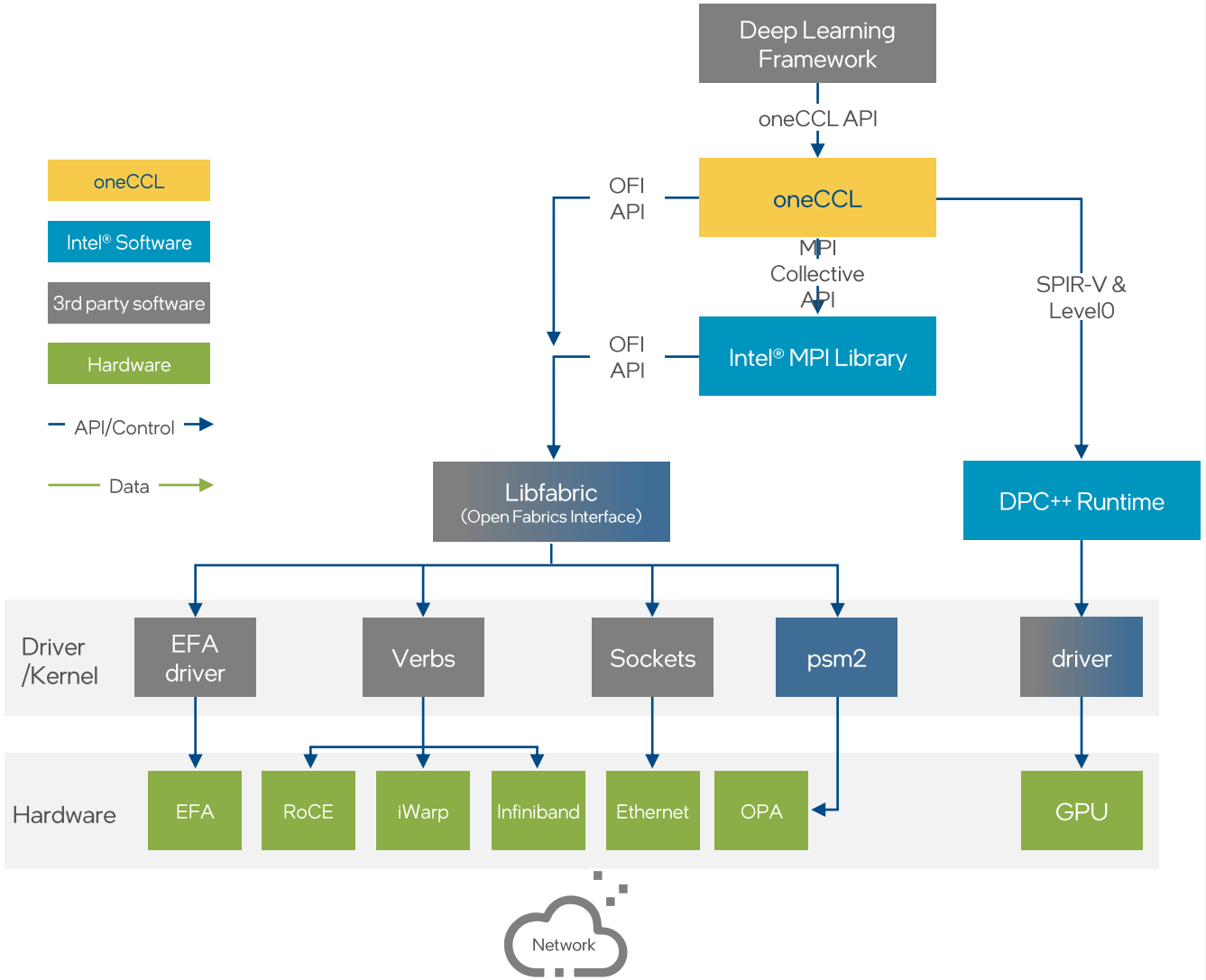
Optimize Communication Patterns

Provides optimized communication patterns for high performance on Intel CPUs & GPUs to distribute model training across multiple nodes

Transparently supports many interconnects, such as Intel® Omni-Path Architecture, InfiniBand, & Ethernet

Built on top of lower-level communication middleware-MPI & libfabrics

Enables efficient implementations of collectives used for deep learning training-all-gather, all-reduce, & reduce-scatter



Intel® VTune™ Profiler

DPC++ Profiling-Tune for CPU, GPU & FPGA

Analyze Data Parallel C++ (DPC++)

See the lines of DPC++ that consume the most time

Tune for Intel CPUs, GPUs & FPGAs

Optimize for any supported hardware accelerator

Optimize Offload

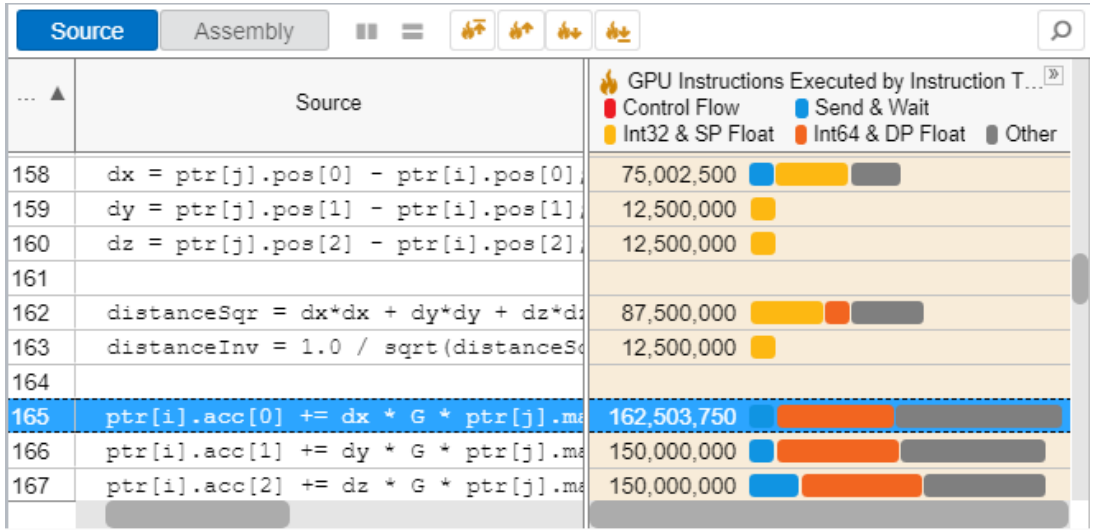
Tune OpenMP offload performance

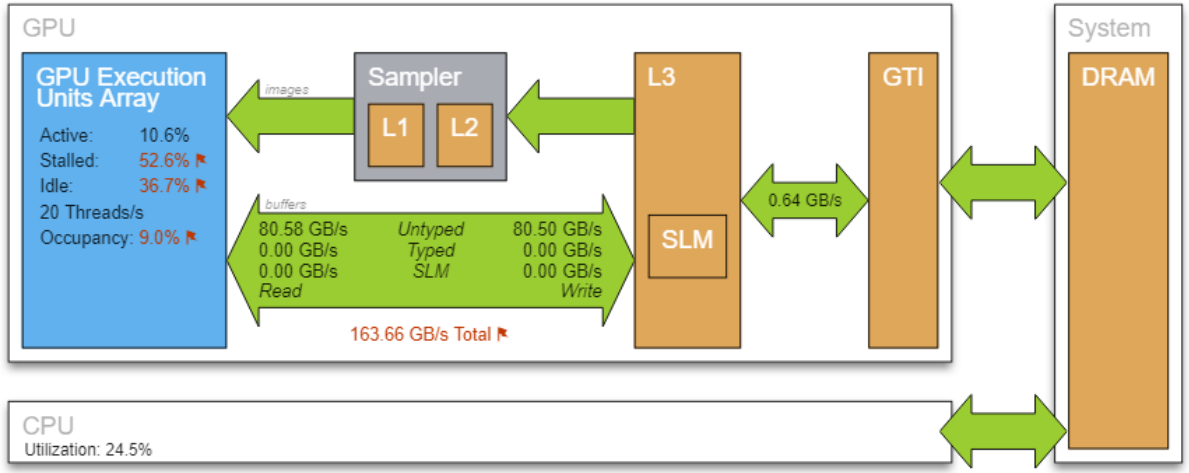
Wide Range of Performance Profiles

CPU, GPU, FPGA, threading, memory, cache, storage...

Supports Popular Languages

DPC++, C, C++, Fortran, Python, Go, Java, or a mix





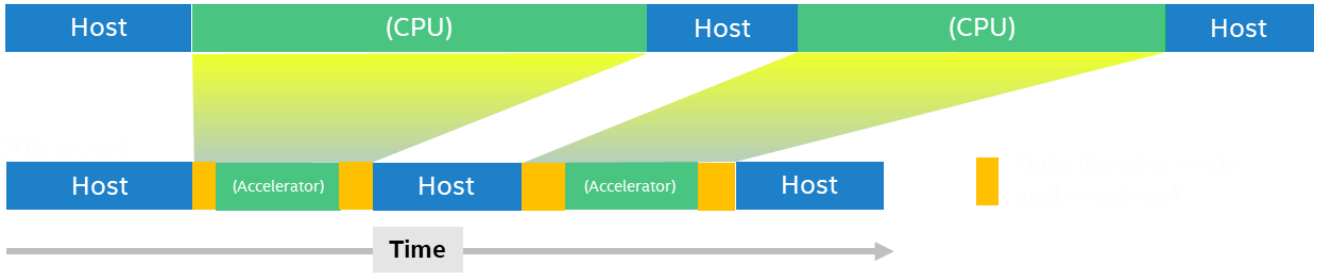
There will still be a need to tune for each architecture.

Intel® Advisor

Design Assistant - Design for Modern Hardware

Offload Advisor

Estimate performance of offloading to an accelerator

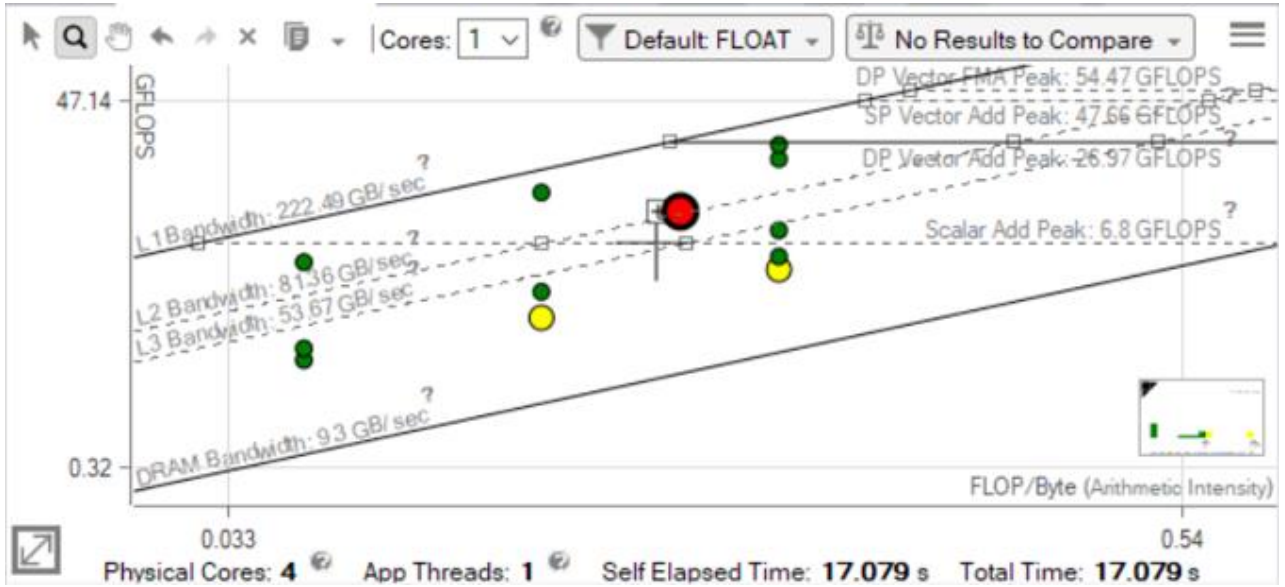


Roofline Analysis

Optimize CPU/GPU code for memory and compute

Vectorization Advisor

Add and optimize vectorization



Threading Advisor

Add effective threading to unthreaded applications

Flow Graph Analyzer

Create and analyze efficient flow graphs

There will still be a need to tune for each architecture.

Intel® Distribution of GDB

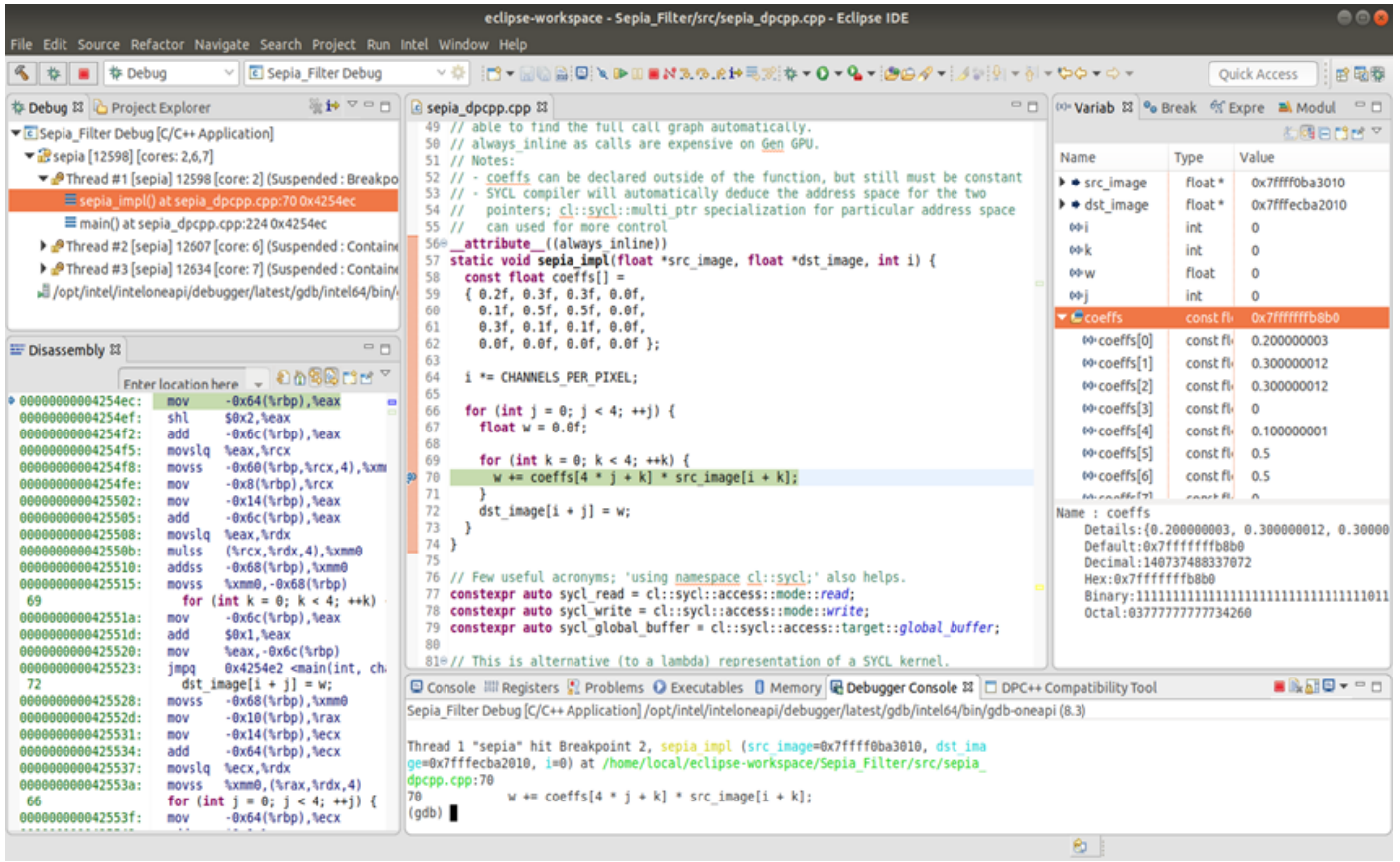
DPC++ Debug - Heterogeneous Application Debug

High-level language debug support

Multiple accelerator support:
Intel CPU, GPU, FPGA emulation

Auto-detect accelerator architecture during application runtime

Non-proprietary open-source solution based on GDB



oneAPI for FPGA

DPC++ Coding for Spatial Architecture

For Experienced FPGA Developers

Ease of Use

Experienced FPGA users can take advantage of a streamlined programming model using Data Parallel C++

Real Time Processing

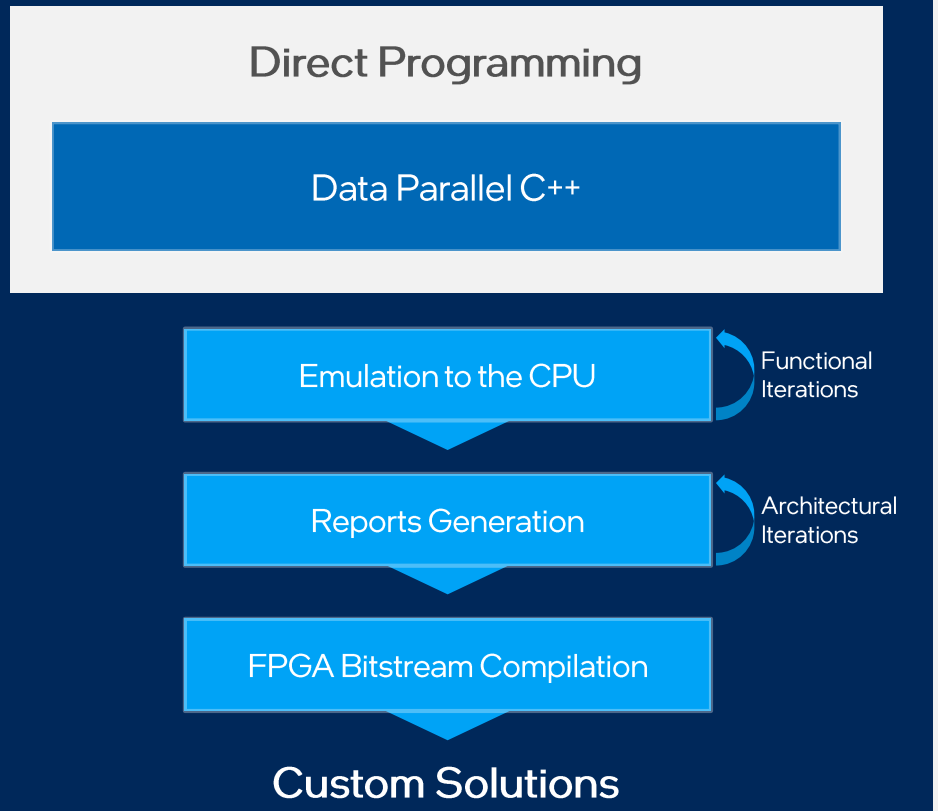
Process data faster with deterministic low latency and high throughput

Runtime Analysis Support

Collect profiling data at runtime to analyze CPU and FPGA interaction with Intel® VTune™ Profiler

Device Specific Optimizations

One-day class provides experienced FPGA developers training to begin optimizing oneAPI code for FPGA



Domain-specific Toolkits for Specialized Workloads

- Intel® oneAPI HPC Toolkit
- Intel® oneAPI IoT Toolkit
- Intel® oneAPI Rendering Toolkit
- Intel® AI Analytics Toolkit, powered by oneAPI
- Intel® Distribution of OpenVINO™ toolkit, powered by oneAPI

Intel® oneAPI Tools for HPC

Intel® oneAPI HPC Toolkit

Deliver Fast Applications that Scale

What is it?

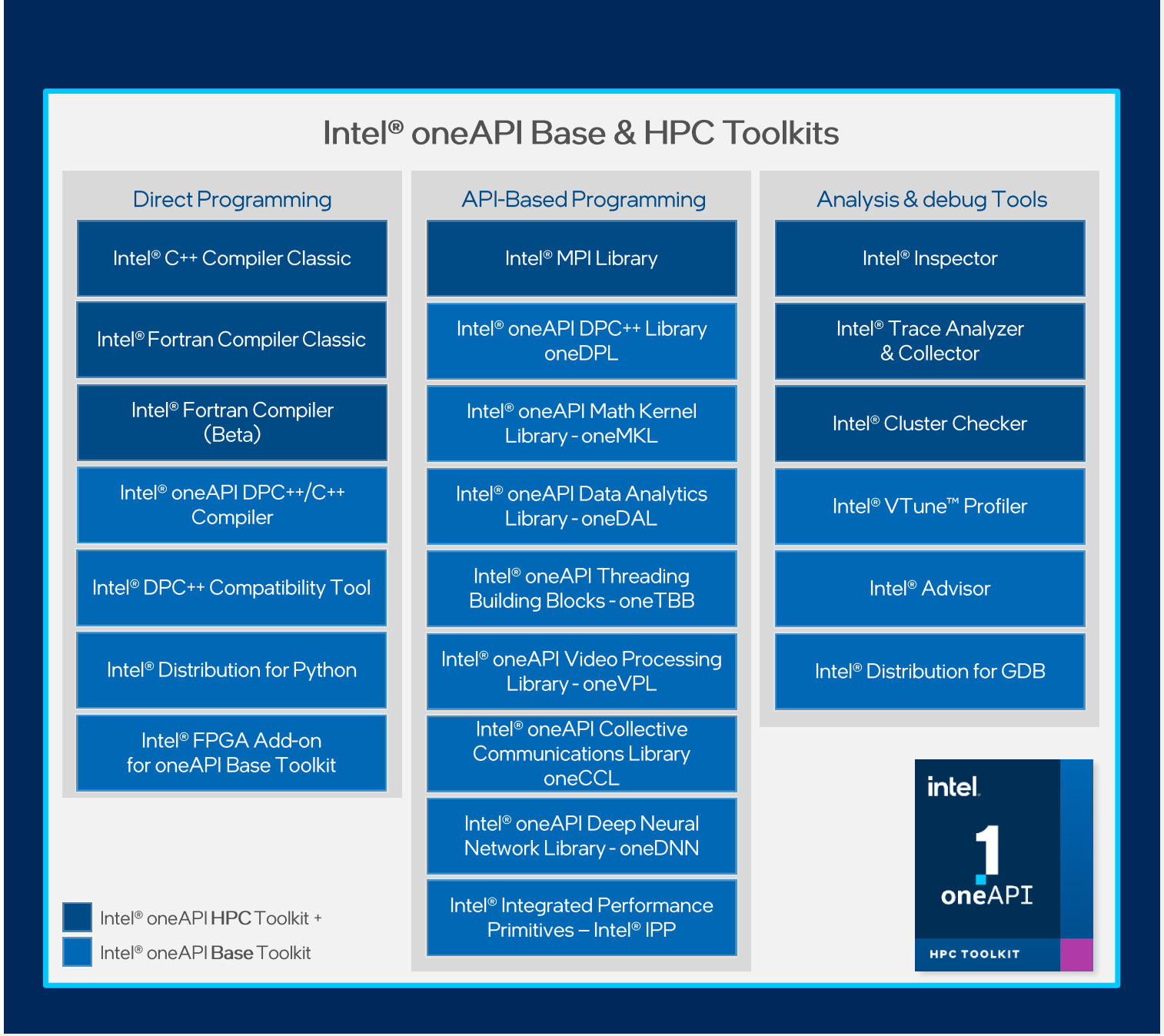
A toolkit that adds to the Intel® oneAPI Base Toolkit for building high-performance, scalable parallel code on C++, Fortran, OpenMP & MPI from enterprise to cloud, and HPC to AI applications.

Who needs this product?

- OEMs/ISVs
- C++, Fortran, OpenMP, MPI Developers

Why is this important?

- Accelerate performance on Intel® Xeon® & Core™ Processors and Intel® Accelerators
- Deliver fast, scalable, reliable parallel code with less effort built on industry standards



Learn More: intel.com/oneAPI-HPCKit

[Back to Domain-specific Toolkits for Specialized Workloads](#)

Intel® oneAPI Tools for IoT

Intel® IoT Toolkit

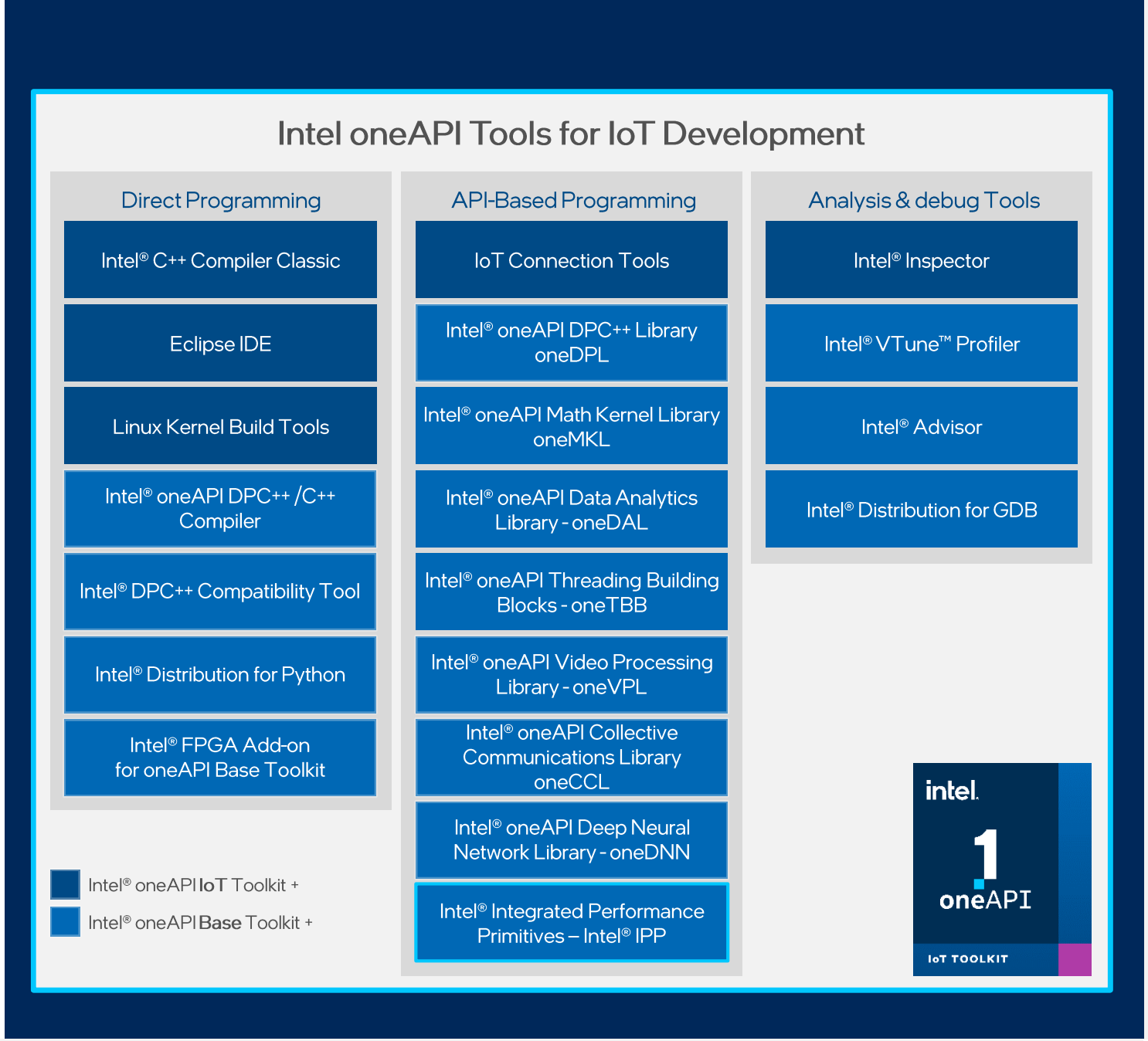
Delivers what developers need to accelerate development of IoT applications for smart, connected devices that run at the networks edge

Who Uses It?

A broad range of application developers creating highly reliable IoT devices running on Intel CPUs, GPUs, & FPGAs

Top Features/Benefits

- Leverage more cores & built-in technologies in Intel® architecture-based platforms through optimized compilers & libraries
- Easily connect sensors to devices, and devices to cloud with IoT Connection Tools
- Speed development & maintenance of Yocto Project platform projects
- Develop with confidence with powerful analysis tools to identify threading, memory & offloading optimization opportunities
- DPC++ compatibility tool helps migrate existing code written in CUDA



Learn More: intel.com/oneAPI-IoTKit

Back to Domain-specific Toolkits for Specialized Workloads

Render Your Vision in Highest Fidelity

Intel® oneAPI Rendering Toolkit

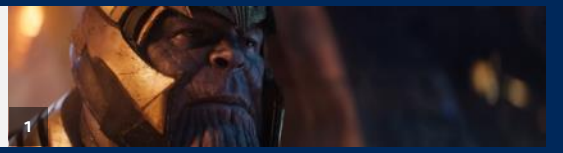
Powerful Libraries for High-Fidelity Visualization Applications

- Deliver high-performance, high-fidelity visualization applications on Intel® architecture
- Create amazing visual, hyper-realistic renderings via ray tracing with global illumination
- Access all system memory space to create renderings using the largest data sets
- Flexible, cost efficient development using open source libraries

intel. 1 oneAPI RENDERING TOOLKIT

Intel oneAPI Rendering & Ray Tracing Libraries

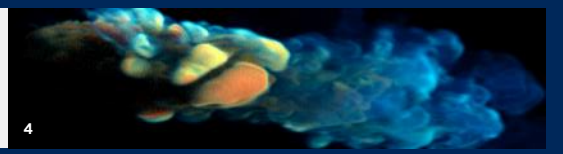
Intel® Embree
High-Performance, Feature-Rich Ray Tracing & Photorealistic Rendering



Intel® Open Image Denoise
AI-Accelerated Denoiser for Superior Visual Quality

Intel® OpenSWR
High-Performance, Scalable, OpenGL*-Compatible Rasterizer

Intel® Open Volume Kernel Library
Render & Simulate 3D Spatial Data Processing



Intel® OSPRay
Scalable, Portable, Distributed Rendering API

Intel® OSPRay Studio
Real-time rendering through a graphical user interface with this new scene graph application

Intel® OSPRay for Hydra
Connect the Rendering Toolkit libraries to Universal Scene Description Hydra Rendering subsystem via plugin

[1] Avengers: Infinity War - Digital Domain, Marvel Studios, Chaos Group V-Ray
[2] Scene courtesy of Frank Meinl
[3] Model from Leigh Orf at University of Wisconsin. For more tornado visualization, visit Leigh Orf's site
[4] Smoke volume, data courtesy OpenVDB example repository
[5] Moana Island Scene, Walt Disney Animation Studios , publicly available dataset: 15fps+,~160 billion prims

Learn More: intel.com/oneAPI-RenderKit

Back to Domain-specific Toolkits for Specialized Workloads

Intel® AI Analytics Toolkit

Powered by oneAPI

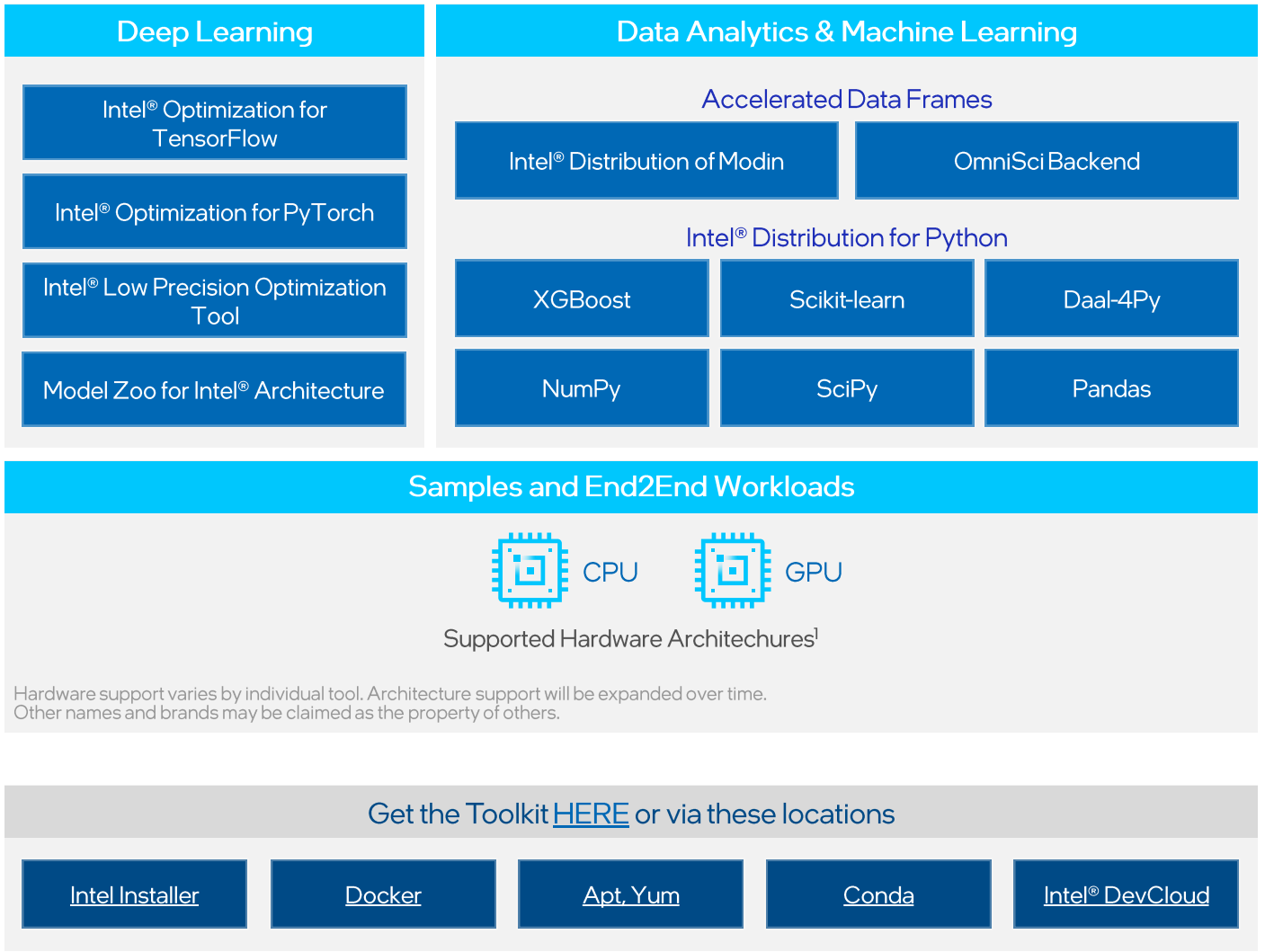
Accelerate end-to-end AI and data analytics pipelines with libraries optimized for Intel® architectures

Who Uses It?

Data scientists, AI researchers, ML and DL developers, AI application developers

Top Features/Benefits

- Deep learning performance for training and inference with Intel optimized DL frameworks and tools
- Drop-in acceleration for data analytics and machine learning workflows with compute-intensive Python packages



Learn More: software.intel.com/oneapi/ai-kit

Back to Domain-specific Toolkits for Specialized Workloads

Intel® Distribution of OpenVINO™ toolkit

Powered by oneAPI

Deliver High-Performance Deep Learning Inference

A toolkit to accelerate development of high-performance deep learning inference & computer vision in vision/AI applications used from edge to cloud. It enables deep learning on hardware accelerators & easy deployment across Intel® CPUs, GPUs, FPGAs, VPUs.

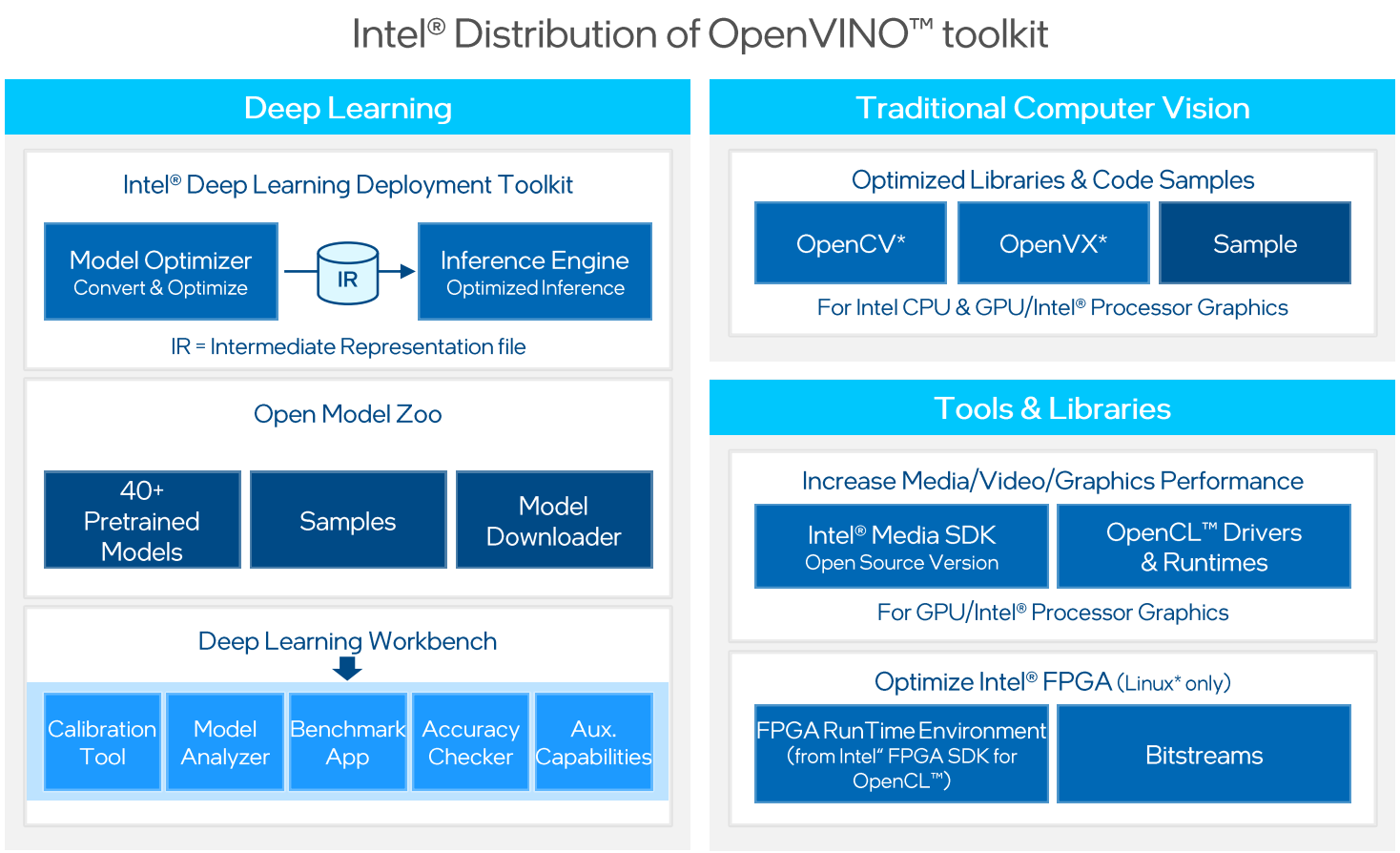
Who needs this product?

- Computer vision, deep learning software developers
- Data scientists
- OEMs, ISVs, System Integrators

Usages

Security surveillance, robotics, retail, healthcare, AI, office automation, transportation, non-vision use cases (speech, NLP, Audio, text) & more

Edge AI & Vision Alliance 2019 VISION PRODUCT OF THE YEAR



Back to Domain-specific Toolkits for Specialized Workloads

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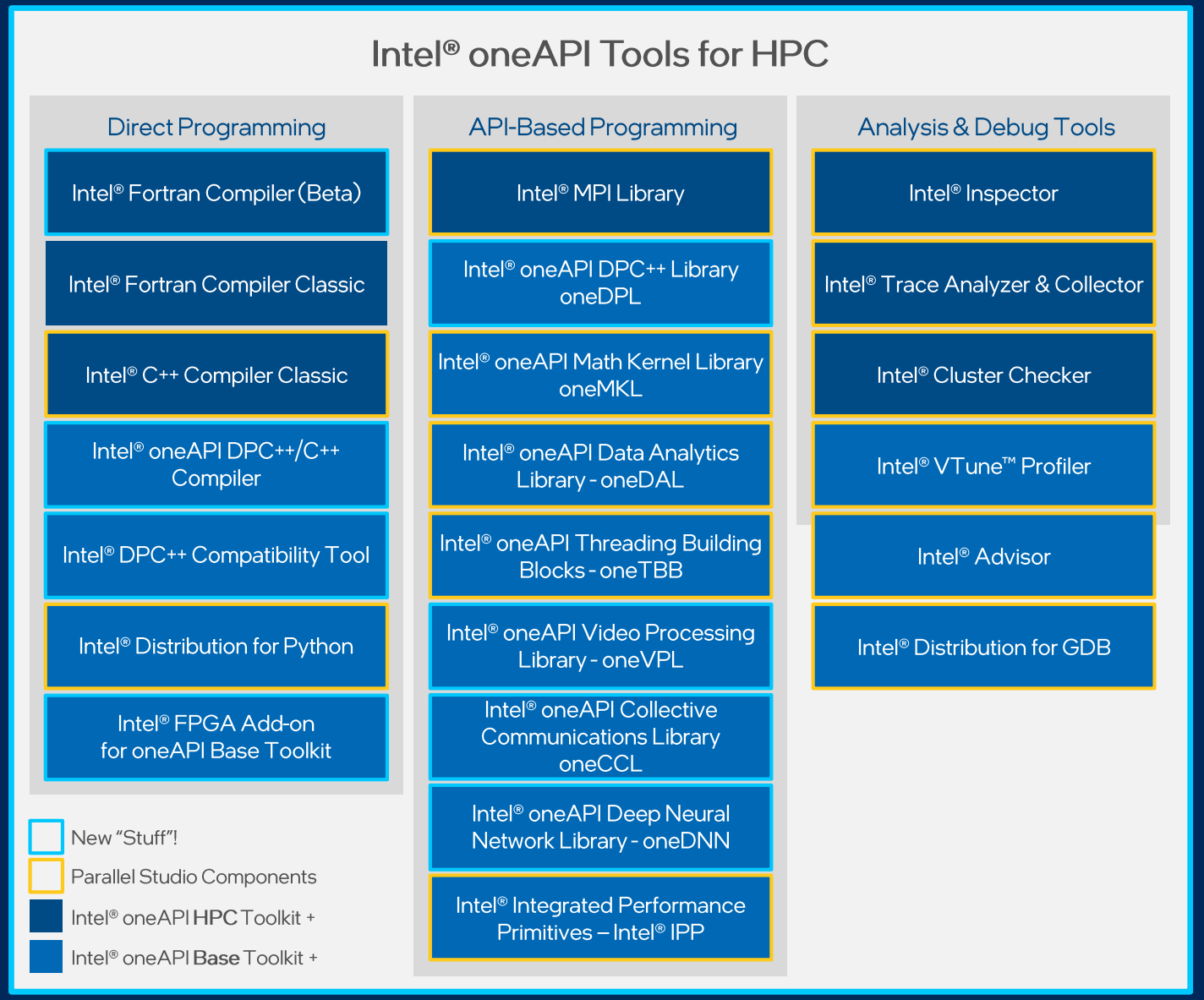
Notice revision #20110804

Backup

Intel® Parallel Studio XE Product Transition

All components delivered today will be available in oneAPI Toolkits along with ***new "Stuff"***

- Intel Priority Support continues without interruption
- Transition goal from Parallel Studio to the oneAPI Toolkits is to make it as smooth as possible for customers
- Existing customers will be getting Intel® oneAPI Base & HPC Toolkits as if they are the next release of what they have
- Protects and extends customers investment in Intel Software development tools



Debug Memory & Threading

Intel® Inspector

Deliver Reliable Applications

Correctness Tools Increase ROI by 12%-21%1

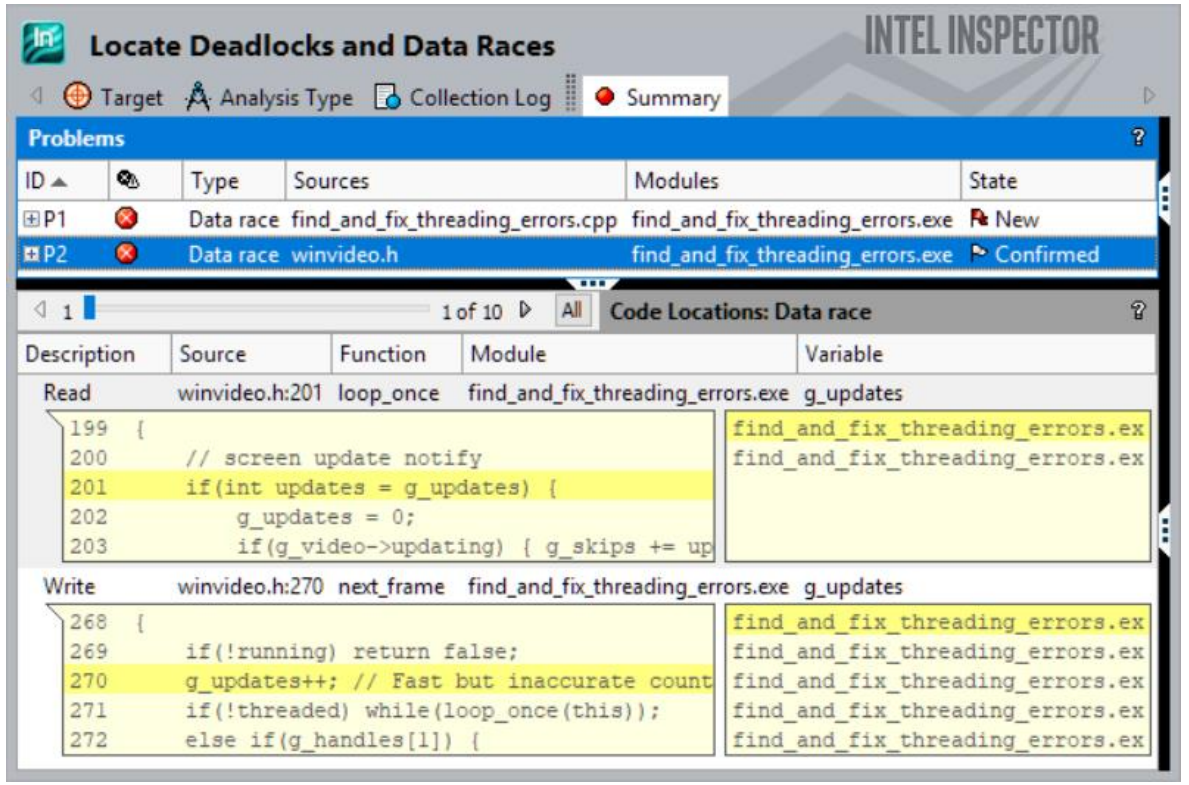
- Errors found earlier are less expensive to fix
- Races & deadlocks not easily reproduced
- Memory errors are hard to find without a tool

Faster Diagnosis with Debugger Breakpoints

- Breakpoint set just before the problem occurs
- Examine variables and threads with the debugger

Debug Persistent Memory Errors

Missing cache flushes / store fences and more



Learn More: software.intel.com/inspector

[1] **Cost Factors – Square Project Analysis** - CERT: U.S. Computer Emergency Readiness Team, and Carnegie Mellon CyLab NIST: National Institute of Standards & Technology: Square Project Results

What's New in Intel® oneAPI Toolkits

Major feature updates since November 2019 Beta release, learn more: Intel oneAPI Updates & product release notes

Intel® oneAPI Products: Overall improvements to performance, functionality and stability - enhanced Intel CPU-GPU systems support

- **DPC++ –** Improved language conciseness, broadened support for Unified Shared Memory programming
- **Intel® oneAPI Libraries –** New and enhanced GPU capabilities, + other functions: matrix multiplication, machine learning, codecs
- **Intel® Advisor –** Improved analysis capabilities
- **Intel® VTune™ Profiler –** Improved analysis capabilities, added GPU performance metrics, supports Intel Gen9/11 GPUs and pre-released Gen12 (integrated + discrete GPUs), improved GPU Memory Hierarchy diagram, find performance-degrading memory transfers with offload cost profiling for both DPC++ and OpenMP
- **Intel® MPI Library –** Introduced initial GPU pinning support for Intel Xe architecture devices and expanded support for Mellanox ConnectX

Intel® DPC++/C++ Compiler – Improved performance, improved support for mixed-language development (DPC++/OpenMP* composability, OpenMP 5.0/Fortran constructs), Mix inline ninja-level CPU assembly and GPU virtual-instruction-set code with the I

Intel® DPC++ Compatibility Tool – Improved migration of CUDA math, texture, and parallelism library calls

Enhanced FPGA support

- Added support for Intel® Stratix® 10 FPGAs by Intel® oneAPI DPC++ Compiler, Intel® oneAPI DPC++ Library, Intel® Advisor, Intel® VTune™ Profiler, Intel-optimized GDB debugger
- Intel® VTune™ Profiler provides easier workflow for FPGA performance analysis

Intel® oneAPI Rendering Toolkit – Added Intel® Open Volume Kernel Library, and new rendering features to support VDB volumes, new geometries, new light sources; included capabilities to use pre-trained models and retrain filter models for denoising

Intel® AI Analytics Toolkit – Added Model Zoo, GPU support for DBSCAN and SVM algorithms, CPU optimizations for scikit-learn algorithms, bfloat16 datatype support in TensorFlow, torchvision to PyTorch for higher performance, + Intel® Scalable Dataframe Compiler for high-performance Pandas

- Achieve 95% parallelization of Pandas APIs while getting 100% functional compatibility with Intel® Distribution of Modin.
- Accelerate Python math code with the initial release of Data Parallel NumPy (dpnp), a native library and NumPy-like API accelerated with SYCL and Intel® GPU support

Intel® System Debugger – Enhanced target connection assistant and system TraceCLI configuration support, added a system debug sample

Added new and enhanced code samples

Codeplay Launches

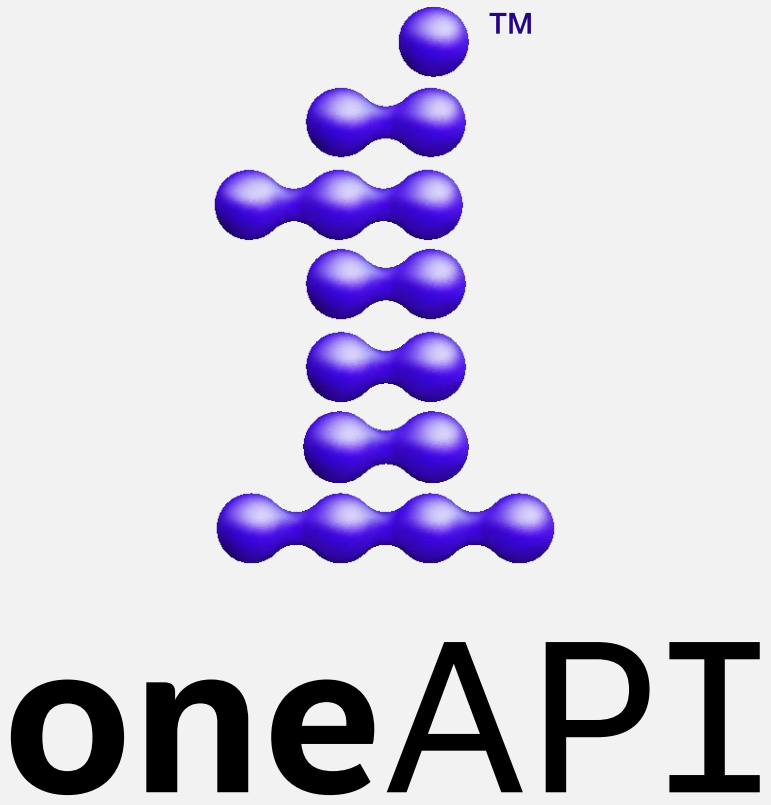
Data Parallel C++ Compiler for Nvidia GPUs

- Now developers can retarget and reuse code between NVIDIA and Intel compute accelerators from a single source base
- Codeplay is the first oneAPI industry contributor to implement a developer tool based on oneAPI specifications
- They leveraged the DPC++ LLVM-based open source project that Intel established
- Codeplay is a key driver of the Khronos SYCL standard, upon with DPC++ is based
- More details in the Codeplay blog post

Other News

Codeplay Brings NVIDIA GPU Support to Industry-Standard Math Library

Intel Open Sources the oneAPI Math Kernel Library Interface



oneAPI

Industry Specification

spec.oneapi.com/oneAPI/

- Notices and Disclaimers
- Contribution Guidelines
- Introduction
- Software Architecture
- Library Interoperability
- oneAPI Elements
- Data Parallel C++ (DPC++)
- oneAPI Data Parallel C++ Library (oneDPL)
- oneAPI Deep Neural Network Library (oneDNN)
- oneAPI Collective Communications Library (oneCCL)
- oneAPI Level Zero (Level Zero)
- oneAPI Data Analytics Library (oneDAL)
- oneAPI Threading Building Blocks (oneTBB)
- oneAPI Video Processing Library (oneVPL)
- oneAPI Math Kernel Library (oneMKL)
- Contributors

Intel® oneAPI DL Framework Developer Toolkit

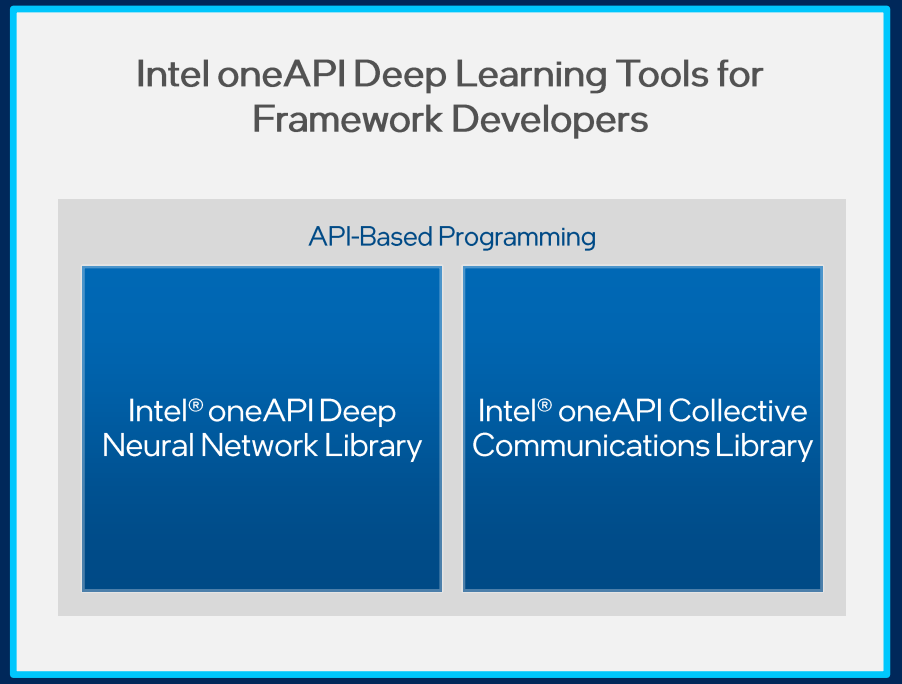
Designed for developers & researchers who want to create the next great deep learning framework or optimize existing ones.

Key Usages

- Deep Learning Framework Development
- Deep Learning Research

Top Features/Benefits

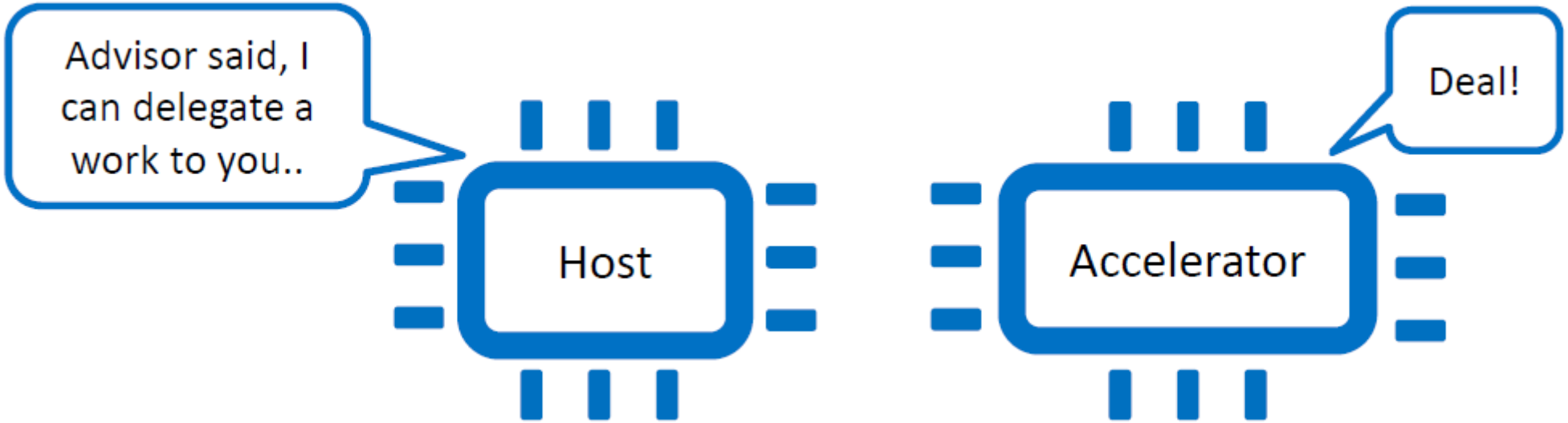
- Create fast deep neural networks that can take advantage of Intel CPUs and accelerators
- Scale your framework from one node to multiple nodes providing faster analysis for the framework's workload



Demo

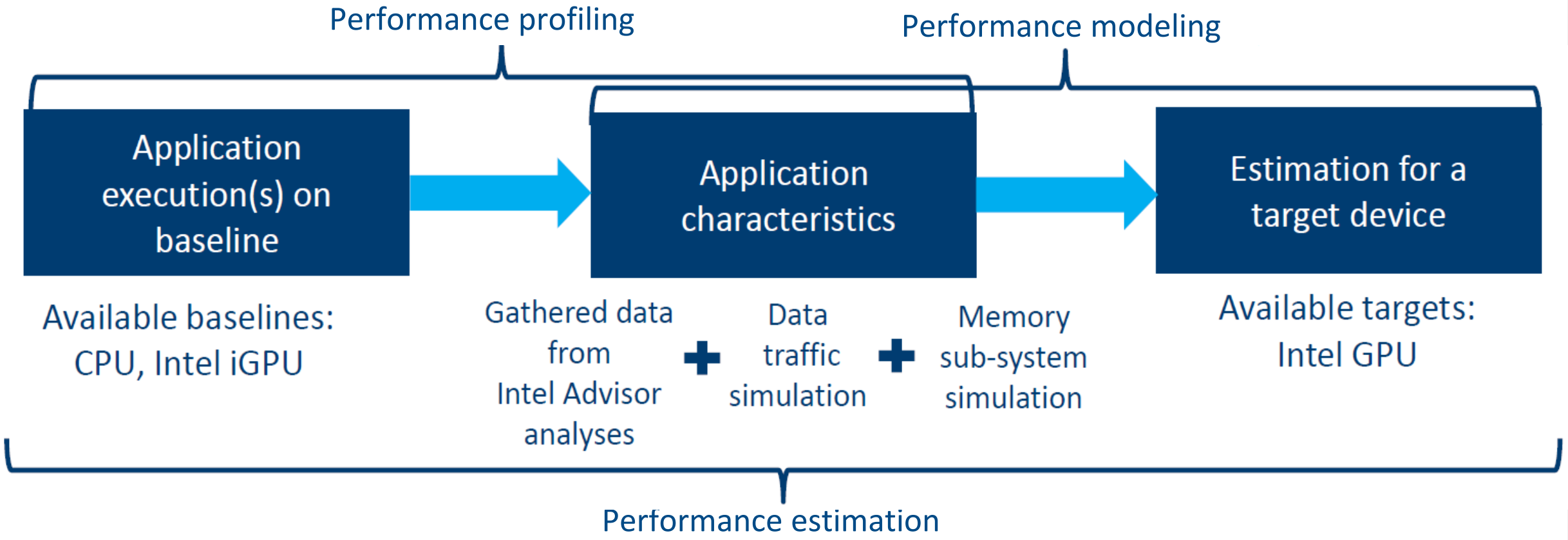
Offload Advisor

- Offload Advisor is designed to help users to port their code to accelerators
- It can identify the portions of a code that are profitable to be offloaded to an accelerator (e.g. GPU)
- It can also predict the code's performance if run on an accelerator and lets you experiment with accelerator configuration parameters

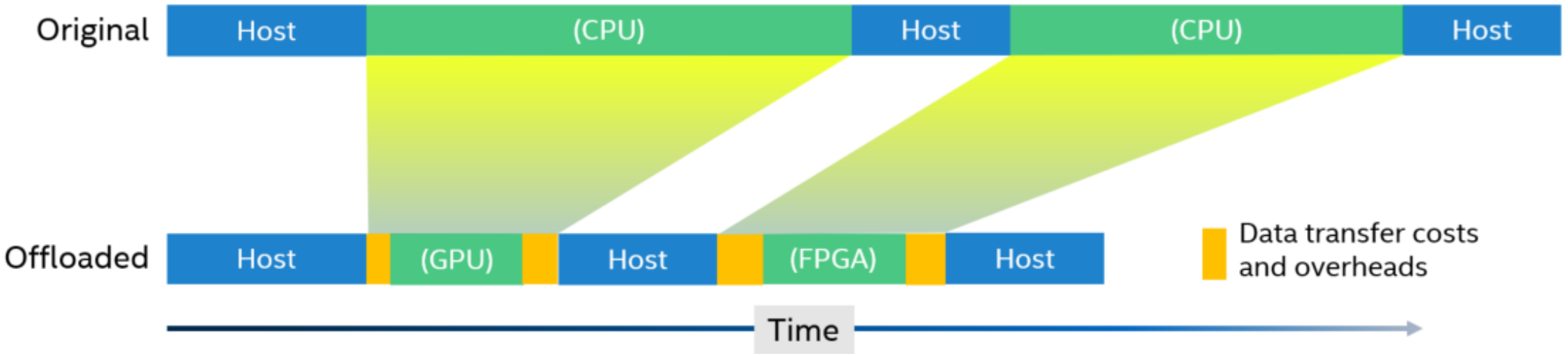


How it works

- Offload Advisor reuses Intel Advisor powerful characterization framework
- Also, it is enriched with data traffic, memory sub-system simulation and analytical performance modeling to enable new Offload Advisor workflow



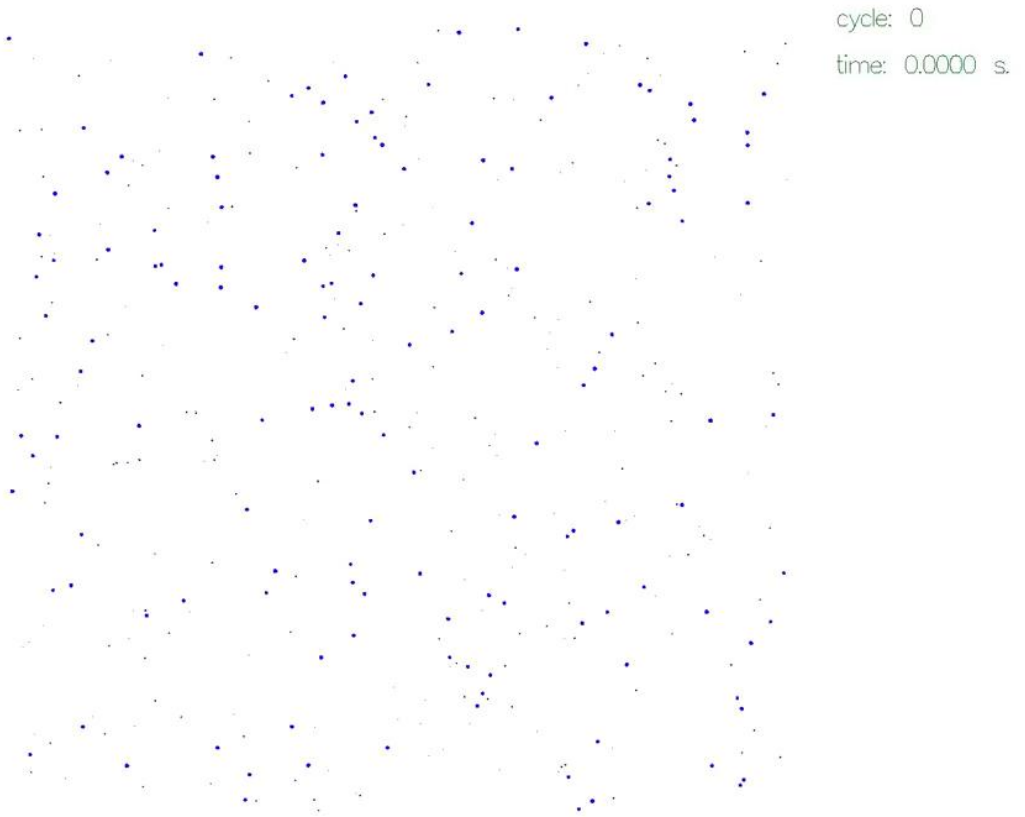
How it works (CPU to GPU offloading)



- Data transfer taxes: copy data between CPU and GPU
- Offload taxes: time to place task to GPU task dispatcher

N-body simulation

In physics and astronomy, an *N*-body simulation is a simulation of a dynamical system of particles, usually under the influence of physical forces, such as gravity.



https://en.wikipedia.org/wiki/N-body_simulation

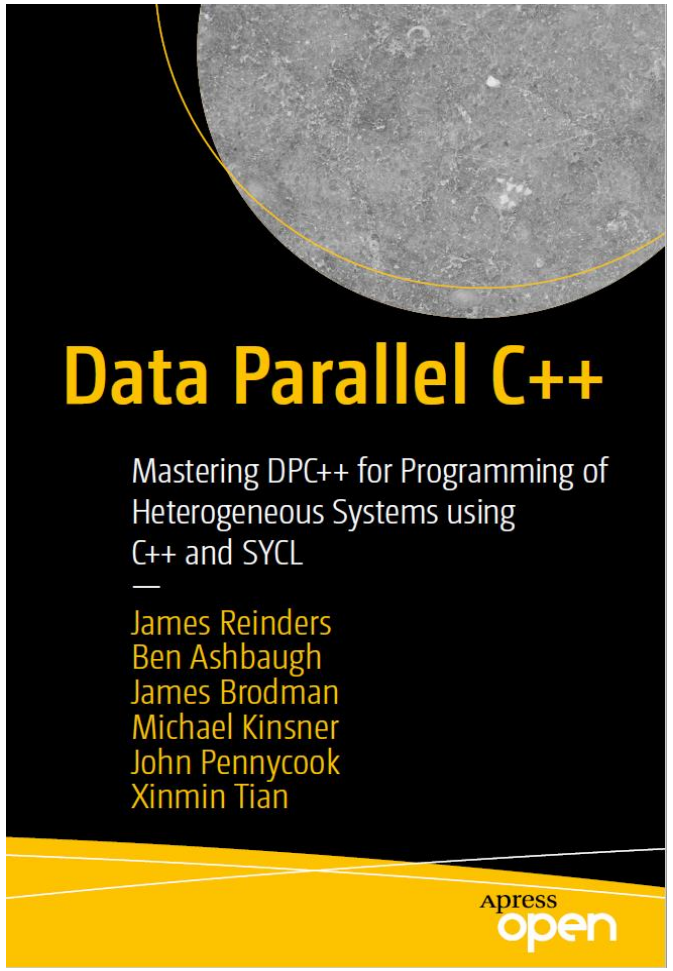
The Lab Activities

- Activity 1: Building and running *N*-body base version
- Activity 2: Running performance estimation for the base version
- Activity 3: Looking at the estimation results
- Activity 4: Rewriting code using DPC++
- Activity 5: Building *N*-body DPC++ version
- Activity 6: Comparing base and DPC++ versions

The Data Parallel C++ Book

You will learn:

- How to accelerate C++ programs using data-parallel programming
- How to target multiple device types (e.g. CPU, GPU, FPGA)
- How to use SYCL and SYCL compilers
- How to connect with computing's heterogeneous future via Intel's oneAPI initiative



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