oneAPI:
A Single Programming Model to Deliver Cross-Architecture Performance

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AGENDA

oneAPI Concept and Industry Initiative

oneAPI Tools and Toolkits Overview

Questions and Answers

PROGRAMMING CHALLENGES FOR MULTIPLE ARCHITECTURES

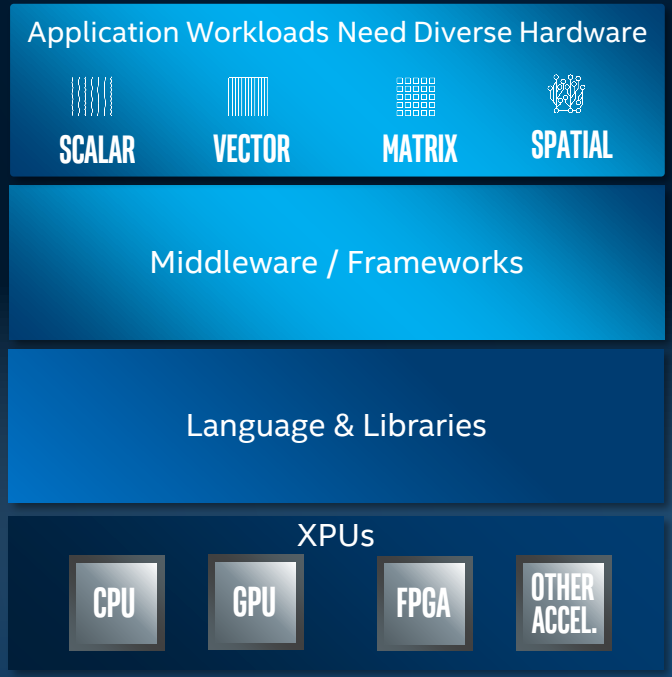
Growth in specialized workloads

No common programming language or APIs

Inconsistent tool support across platforms

Each platform requires unique software investment

Diverse set of data-centric hardware required



INTRODUCING ONEAPI

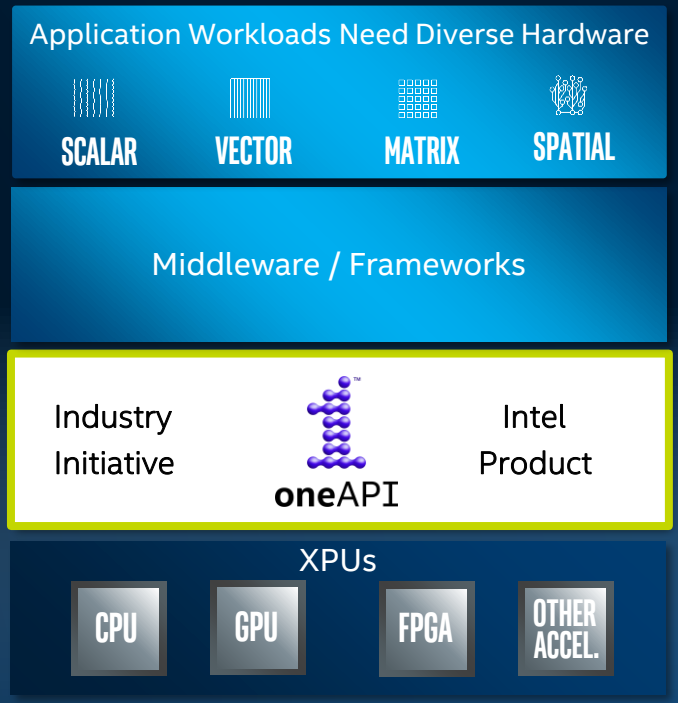
Unified programming model to simplify development across diverse architectures

Unified and simplified language and libraries for expressing parallelism

Uncompromised native high-level language performance

Based on industry standards and open specifications

Interoperable with existing HPC programming models



oneAPI INDUSTRY INITIATIVE
ALTERNATIVE TO SINGLE-VENDOR SOLUTION

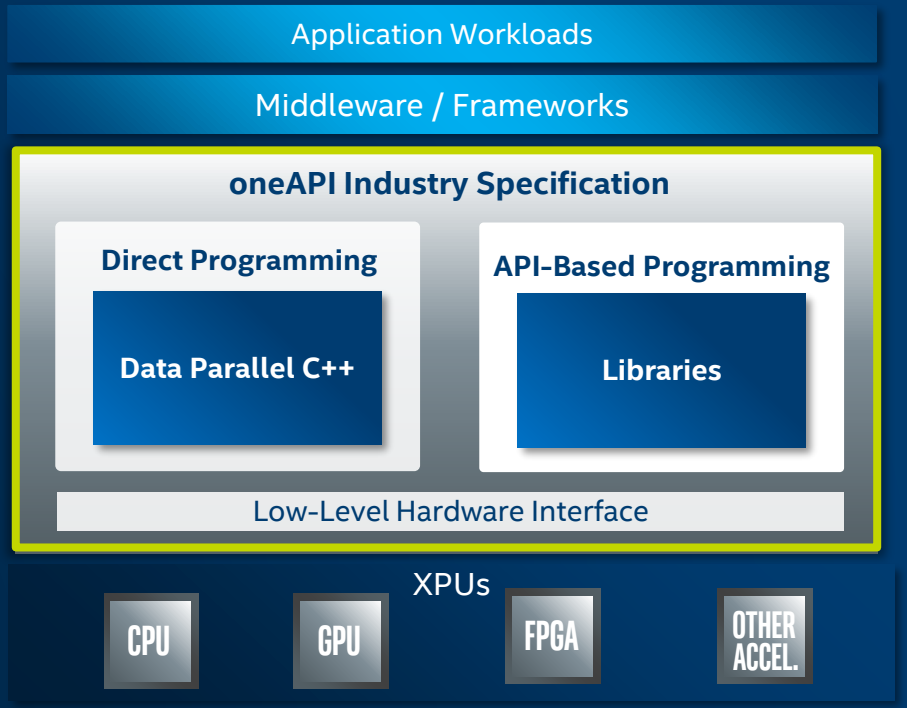
A standards based cross-architecture language, DPC++, based on C++ and SYCL

Powerful APIs designed for acceleration of key domain-specific functions

Low-level hardware interface to provide a hardware abstraction layer to vendors

Open standard to promote community and industry support

Enables code reuse across architectures and vendors



Visit oneapi.com for more details

Some capabilities may differ per architecture and custom-tuning will still be required.

DATA PARALLEL C++

STANDARDS-BASED, CROSS-ARCHITECTURE LANGUAGE

Language 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

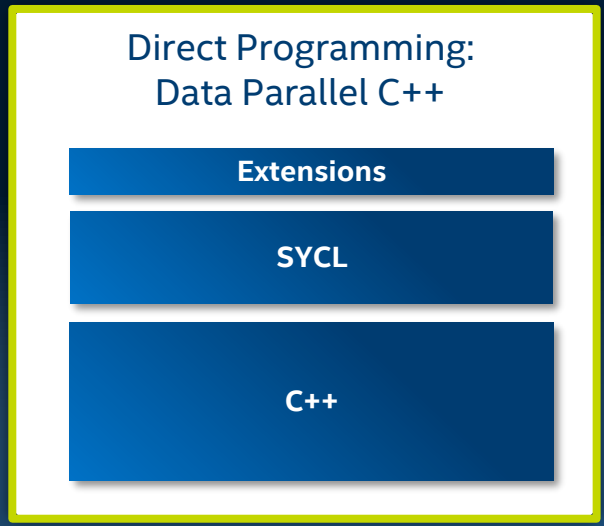
Based on C++

- 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

Community Project to drive language enhancements

- Extensions to simplify data parallel programming
- Open and cooperative development for continued evolution

Builds upon Intel's years of experience in architecture and compilers

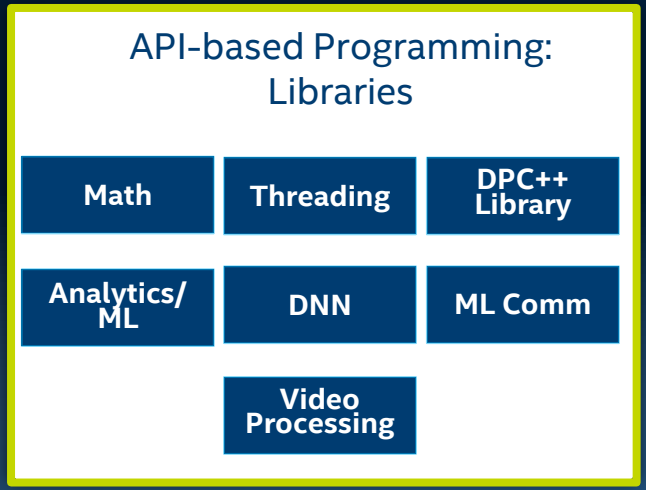


Custom-tuning for each architecture will still be required.

POWERFUL APIs
LIBRARIES

Designed for acceleration of key domain-focused functions

Each can be custom-coded for any platform to deliver uncompromised performance



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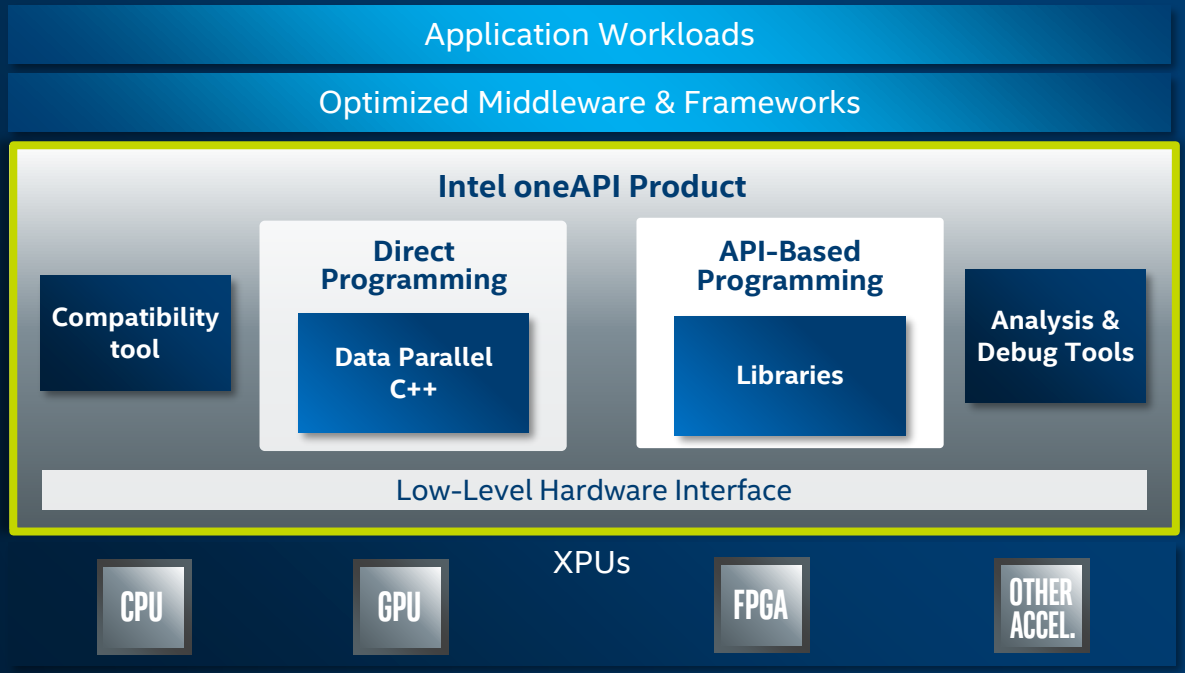
INTEL® ONEAPI PRODUCTS (BETA)

Distributed through a core toolkit and a complementary set of add-on domain-specific toolkits

Includes DPC++ compatibility tool for code migration along with advanced performance analysis and debug tools

Beta Available Now



Visit software.intel.com/oneapi for more details

Some capabilities may differ per architecture and custom-tuning will still be required.

oneAPI INITIATIVE – 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 TOOLKITS (BETA)

TOOLKITS TAILORED TO YOUR NEEDS

Domain-specific sets of tools to get your job done quickly.

Intel® oneAPI Base Toolkit

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

Learn More

Intel® oneAPI HPC Toolkit

Everything HPC developers need to deliver fast C++, Fortran, & OpenMP* applications that scale

Learn More

Intel® oneAPI IoT Toolkit

Tools for building high-performing, efficient, reliable solutions that run at the network's edge

Learn More

Intel® oneAPI DL Framework Developer Toolkit

Tools for developers & researchers who build deep learning frameworks or customize existing ones so applications run faster

Learn More

Intel® oneAPI Rendering Toolkit

Powerful rendering libraries to create high-performance, high-fidelity visualization applications

Learn More

Toolkits Powered by oneAPI

Intel® System Bring-Up Toolkit

Tools to debug & tune power & performance in pre- & post-silicon development

Learn More

Intel® Distribution of OpenVINO™ Toolkit

Tools to build high performance deep learning inference & computer vision applications (production-level tool)

Learn More

Intel® AI Analytics Toolkit

Tools to build applications that leverage machine learning & deep learning models

Learn More

DETAILS ABOUT INTEL® ONEAPI TOOLKITS (BETA)

INTEL® ONEAPI BASE TOOLKIT

INTEL® ONEAPI BASE TOOLKIT (BETA)

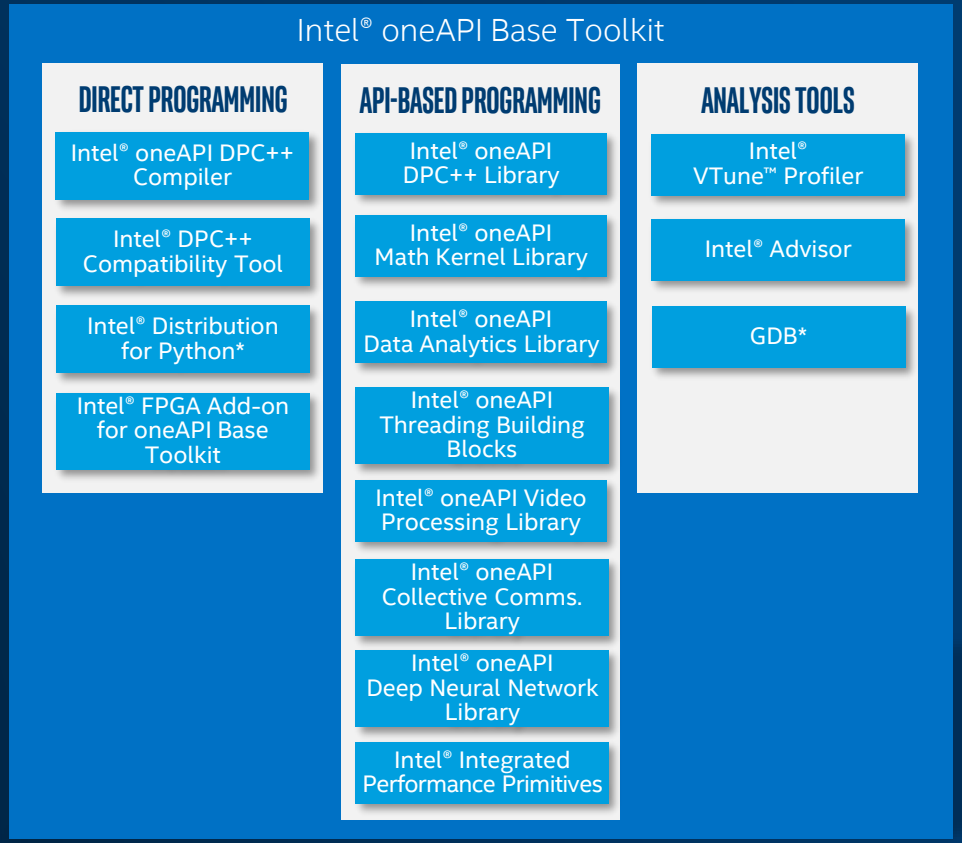
Core set of frequently used tools and libraries for developing high-performance applications across diverse architectures—CPU, GPU, FPGA

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



INTEL® ONEAPI DATA PARALLEL C++ COMPILER (BETA)

PARALLEL PROGRAMMING PRODUCTIVITY & PERFORMANCE

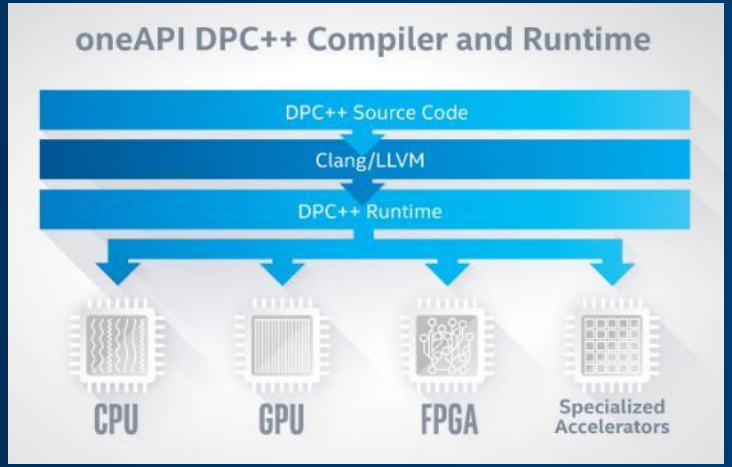
Compiler to deliver uncompromised parallel programming productivity and performance across CPUs and accelerators

- 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 C++ and 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



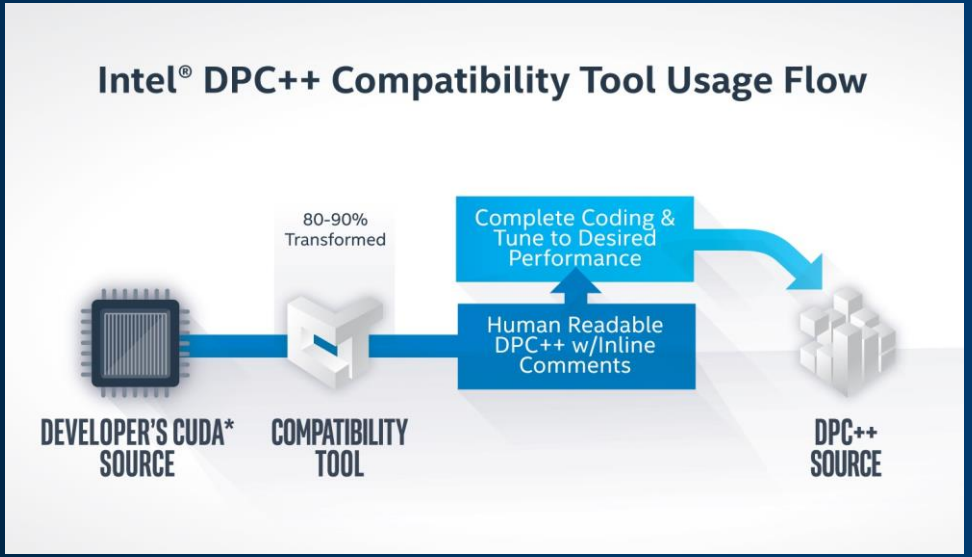
There will still be a need to tune for each architecture.

INTEL® DPC++ COMPATIBILITY TOOL (BETA)
MINIMIZES CODE MIGRATION TIME

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

~80-90% of code migrates automatically

Inline comments are provided to help the developer complete their code



INTEL® ONEAPI DPC++ LIBRARY (BETA)

ACCELERATE DPC++ KERNELS ON CPU, GPU & FPGA

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 VIDEO PROCESSING LIBRARY (BETA)
BOOST MEDIA PERFORMANCE

Boost media and video application performance with hardware-accelerated codecs & 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 DEEP NEURAL NETWORK LIBRARY(BETA)

DELIVER HIGH PERFORMANCE DEEP LEARNING

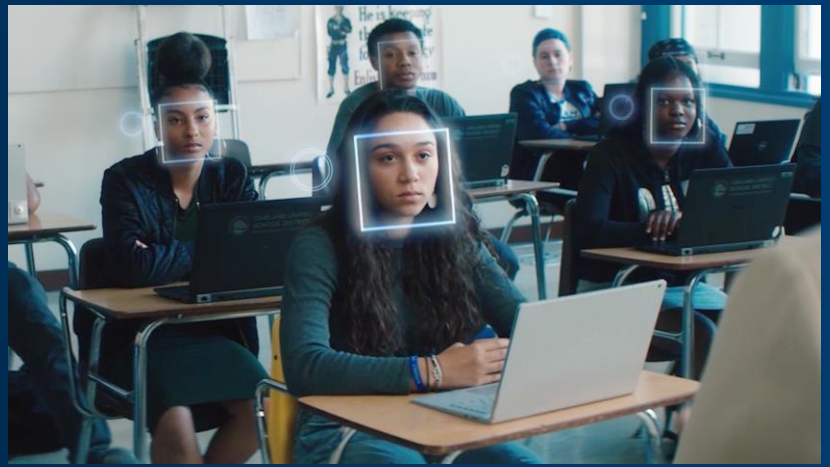
Helps developers create high performance deep learning frameworks

Abstracts out instruction set and other complexities of performance optimizations

Same API for both Intel CPU's and GPU's, use the best technology for the job

Supports Linux*, Windows*

Open sourced for community contributions



INTEL® ONEAPI COLLECTIVE COMMUNICATIONS LIBRARY (BETA)

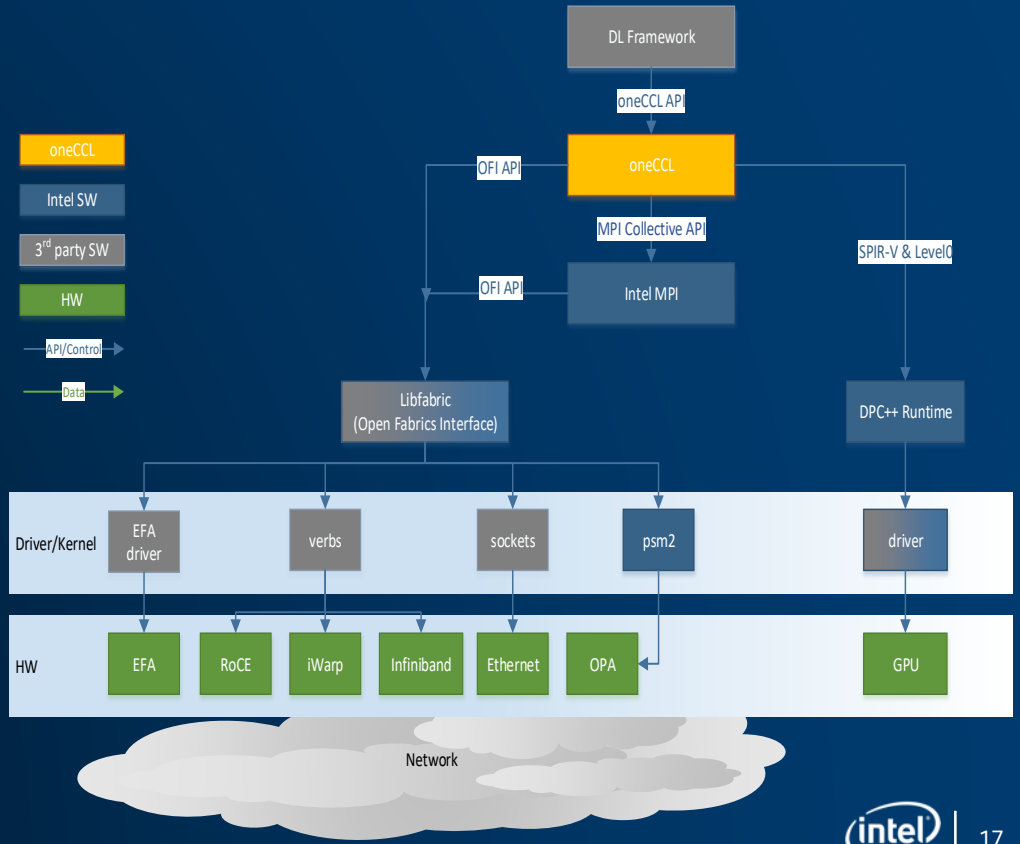
OPTIMIZE COMMUNICATION PATTERNS

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

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

Built on top of lower-level communication middleware – MPI and libfabrics

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



INTEL® VTUNE™ PROFILER (BETA)

DPC++ PROFILING – TUNE FOR CPU, GPU & FPGA

Analyze Data Parallel C++ (DPC++)

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

Tune for CPU, GPU & FPGA

Optimize for any supported hardware accelerator

Optimize Offload

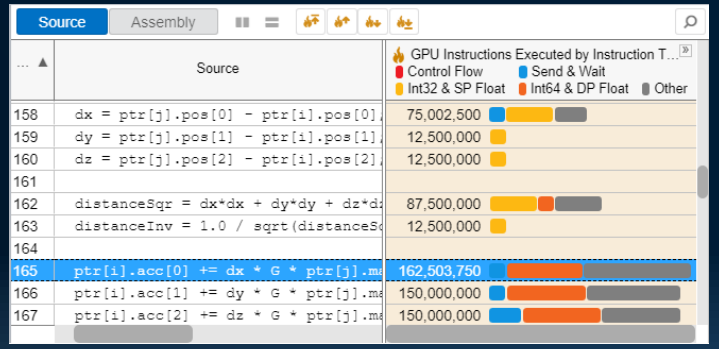
Tune OpenMP* offload performance

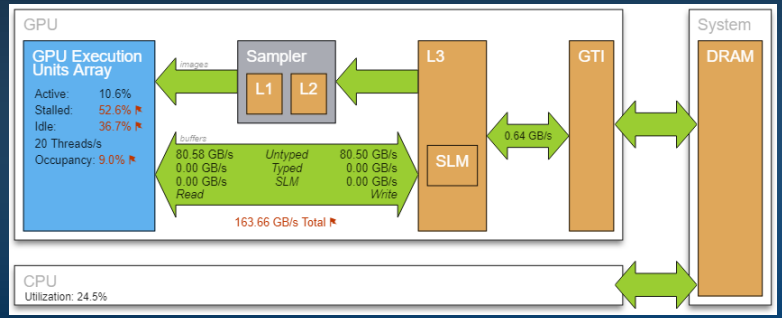
Wide Range of Performance Profiles

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

Most 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 (BETA)

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

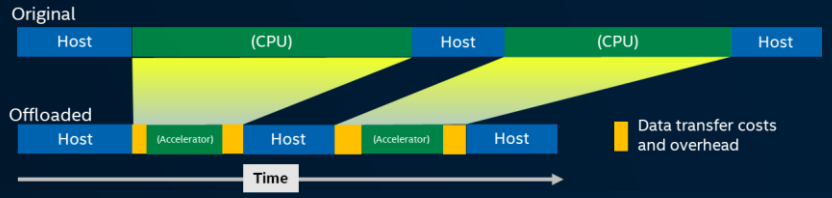
Add and optimize vectorization

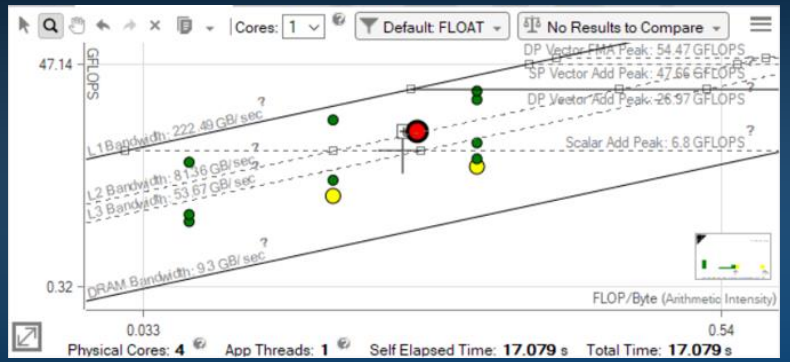
Threading Advisor

Add effective threading to unthreaded applications

Flow Graph Analyzer

Create and analyze efficient flow graphs





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GDB* (BETA)

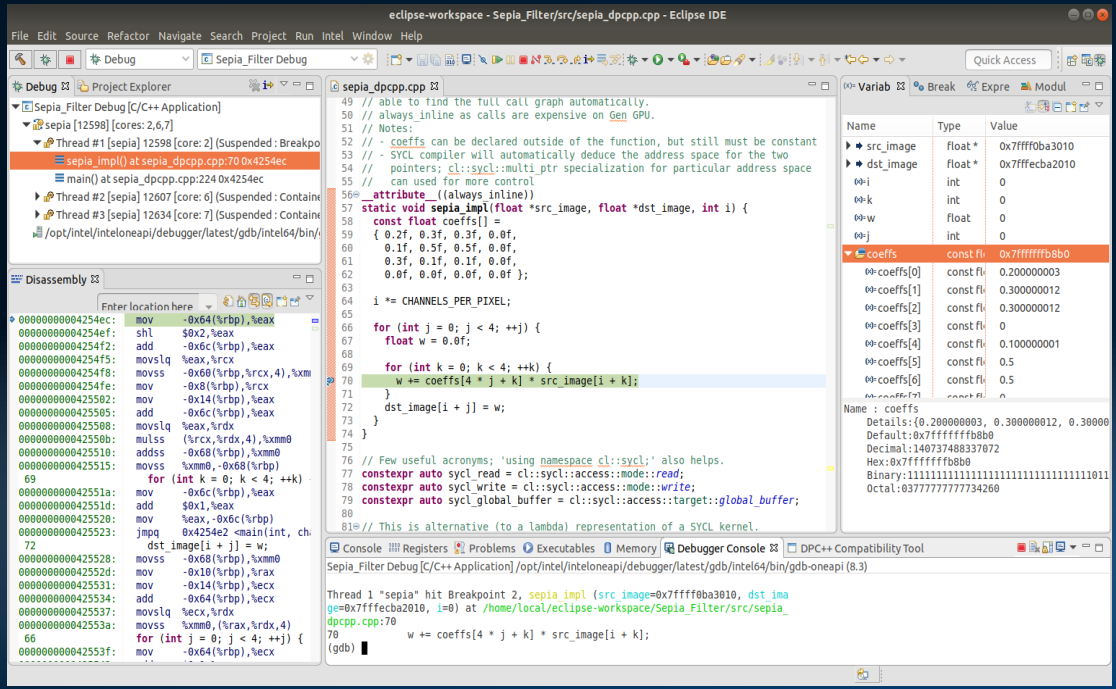
DPC++ DEBUG - HETEROGENEOUS APPLICATION DEBUG

High-level language debug support

Multiple accelerator support: 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 DPC++

Real Time Processing

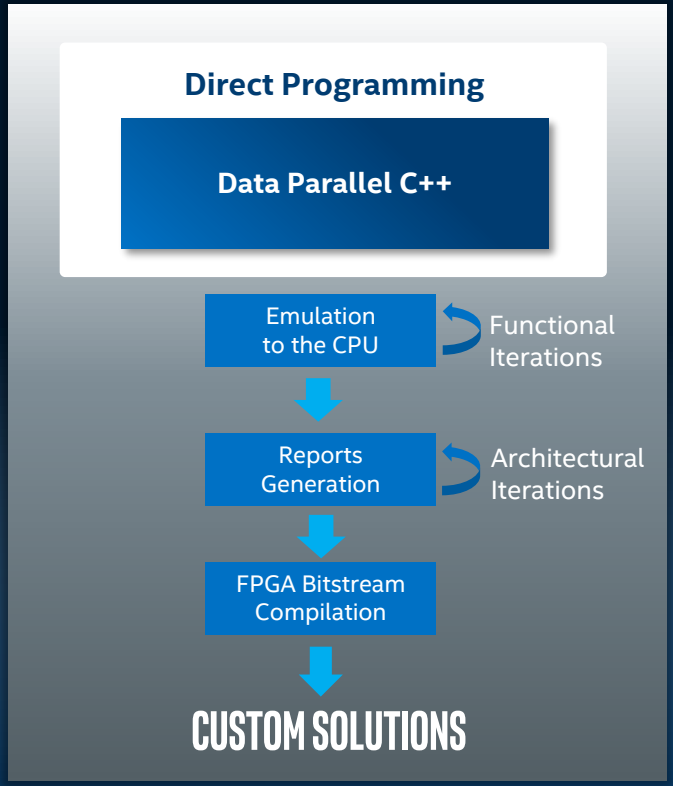
Process data faster with deterministic low latency and high throughput

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



DETAILS ABOUT INTEL® ONEAPI TOOLKITS(BETA)

DOMAIN-SPECIFIC TOOLKITS FOR SPECIALIZED WORKLOADS

INTEL® ONEAPI HPC TOOLKIT (BETA)

A toolkit that makes it easier to build, analyze, optimize & scale HPC applications for Intel® Xeon® Scalable, Intel® Core processors & Intel® Accelerators.

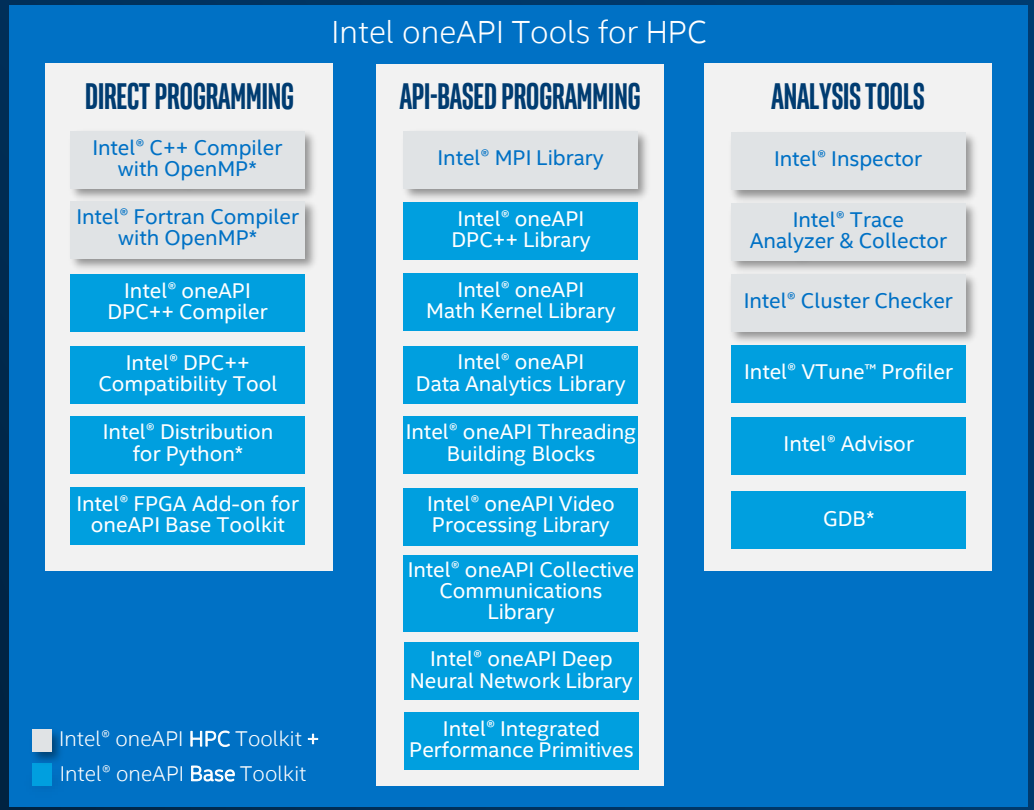
Who Uses It?
C/C++, Fortran, OpenMP & MPI application developers

Top Features/Benefits

Optimized compilers & performance libraries for Intel® architectures

Powerful analysis tools to identify optimization opportunities for threading, memory & offloading

Standards driven to scale forward & preserve development investment



INTEL® C++ & FORTRAN COMPILERS(BETA)

HIGH PERFORMANCE COMPILERS WITH OPENMP*

Deliver Industry-leading C/C++ & Fortran code performance with OpenMP, unleash the power of the latest Intel® platforms

Develop optimized and vectorized code for Intel® architectures, including Intel® Xeon® processors

Leverage latest language and OpenMP* standards, and compatibility with leading compilers & IDEs

Beta support for Intel GEN9 GPU with OpenMP offload

INTEL® ONEAPI IOT TOOLKIT (BETA)

This toolkit accelerates development of IoT applications for smart connected devices

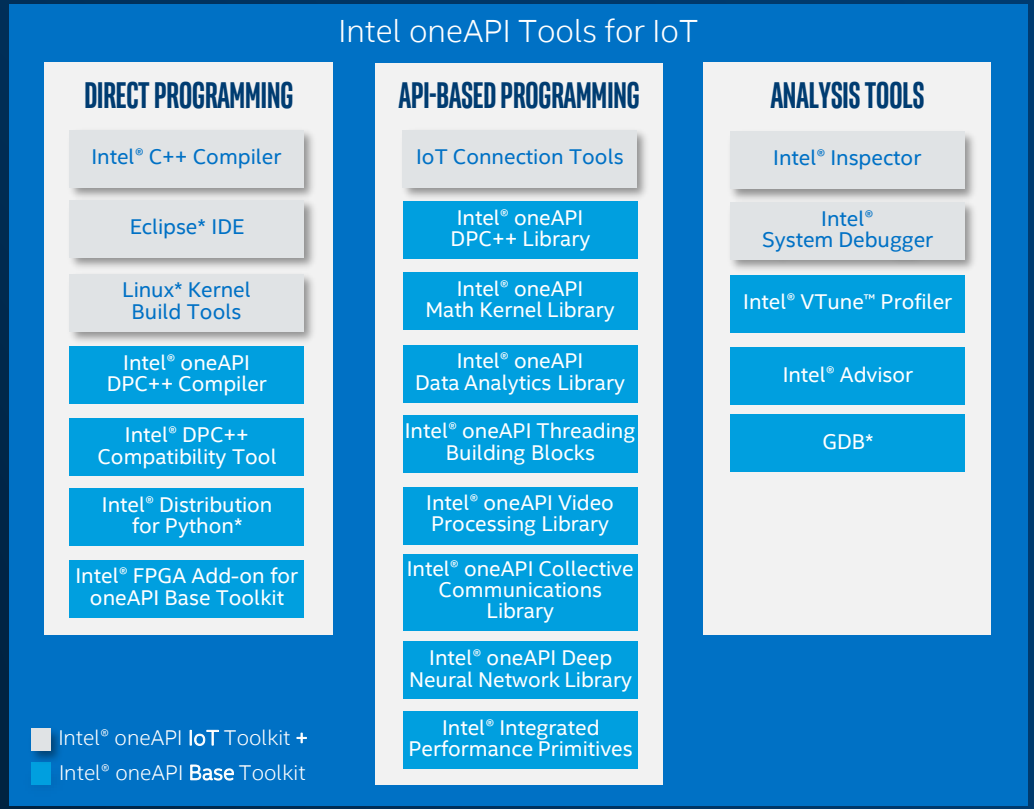
Who Uses It?
Application developers creating highly reliable edge and IoT commercial devices

Top Features/Benefits

Leverage more cores and built-in technologies in platforms based on IA with the Intel® C++ Compiler

Connect sensors to devices and devices to the cloud with the IoT Connection Tools

Speed development and gain deep hardware and software insights with the Intel® System Debugger



INTEL® ONEAPI RENDERING TOOLKIT (BETA)

A set of 5 powerful, rendering libraries that deliver high-performance, high-fidelity, extensible, & efficient visualization applications and solutions on Intel® platforms.

Who Uses It?

Developers working on high-performance, high-fidelity visualization applications

Key Usages

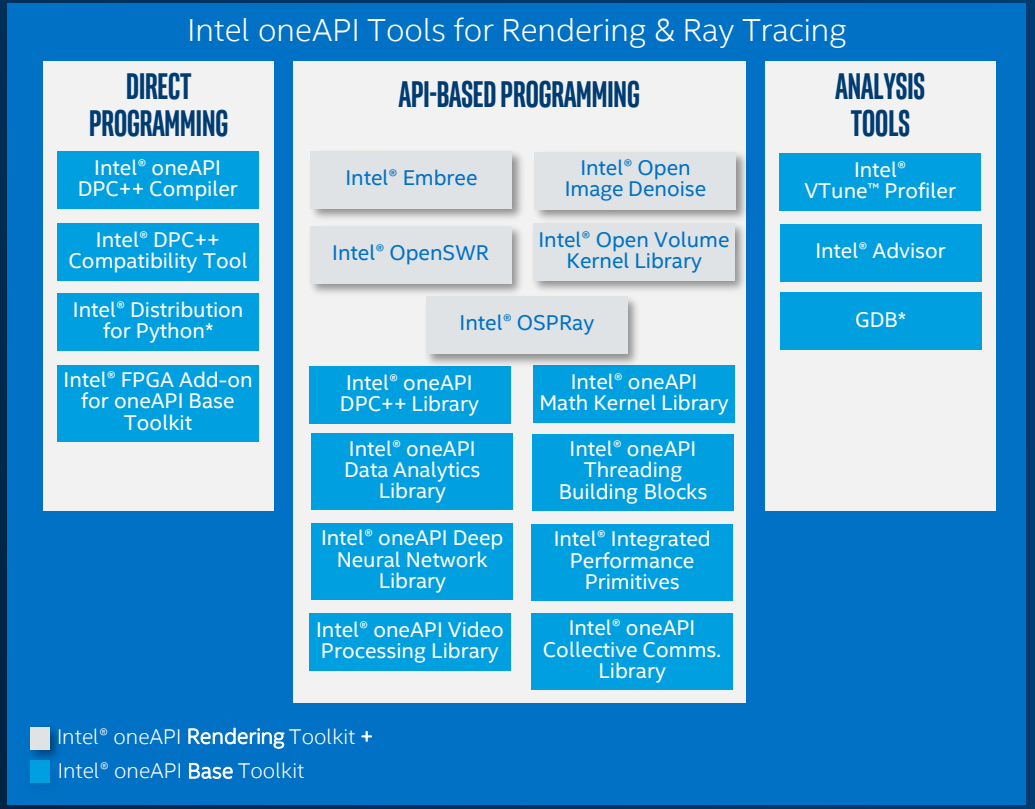
Creation of studio animation/visual effects content & HPC scientific visualization

Top Features/Benefits

Enables parallelism & performance already in your CPU-based Intel® platforms

Gain performance-optimized ray tracing kernels for photorealistic rendering

Efficiently use threading & vectorization to create interactive, high-fidelity applications



INTEL® ONEAPI DL FRAMEWORK DEVELOPER TOOLKIT (BETA)

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

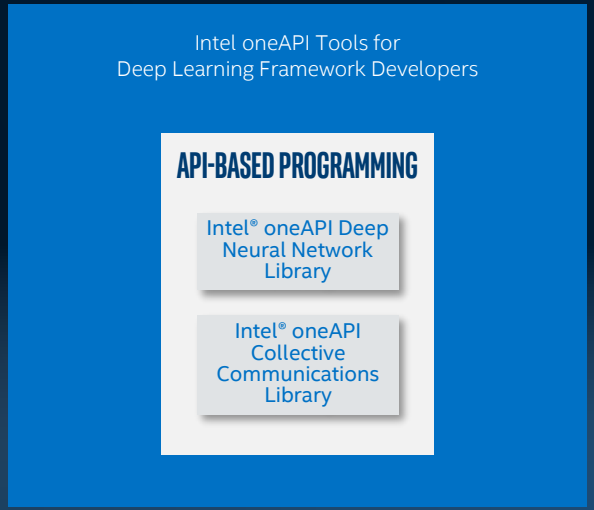
Key Usages

Deep Learning Framework Development
Deep Learning Research

Top Features/Benefits

Create fast deep neural networks that can take advantage of Intel's CPU and accelerators

Scale your framework from one node to multiple nodes providing faster analysis for the framework's workload



INTEL® AI ANALYTICS TOOLKIT (BETA)

A toolkit that provides optimized software tools to accelerate End to End AI development

Who Uses It?

AI Researchers & application developers, data scientists

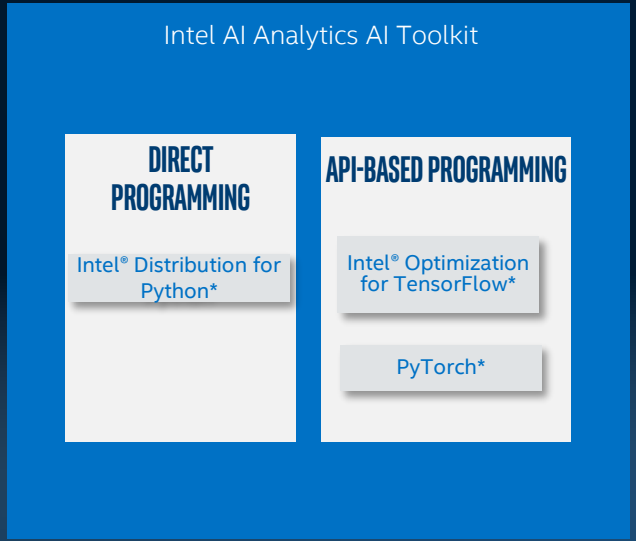
Key Usages

AI Research & applications across Finance, Retail, e-commerce, robotics, transportation & more

Top Features/Benefits

Achieve greater deep learning performance for training and inference phases with optimized frameworks.

Accelerate data science and analytics stages with Python* packages enhanced for Intel® architectures



INTEL® DISTRIBUTION OF OPENVINO TOOLKIT

(GOLD-RELEASED PRODUCTION TOOL)

A toolkit to accelerate development of high performance deep learning inference & computer vision into vision/AI applications used from edge to cloud. It enables deep learning on hardware accelerators & easy deployment across multiple types of Intel® platforms.

Who needs this product?

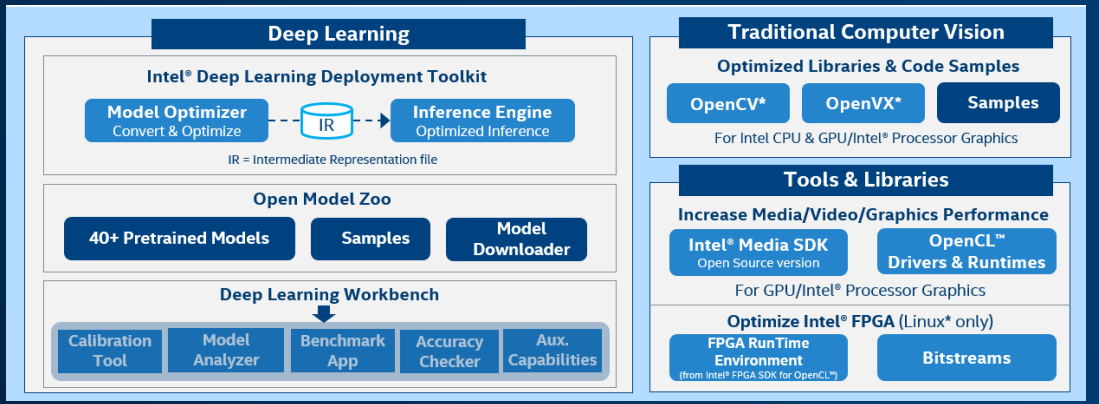
Computer vision, deep learning software developers

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.



INTEL® SYSTEM BRING-UP TOOLKIT (BETA)

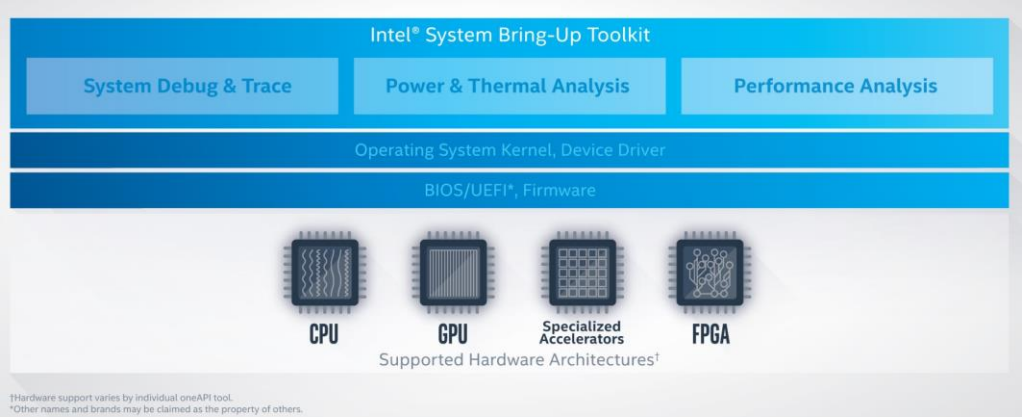
This toolkit helps accelerate system bring-up & optimization for Intel® platforms.

Who Uses It?

Hardware & system software developers creating highly reliable & optimized Intel-based solutions

Key Usages

Used by IoT, client & server customers to bring-up a platform & optimize the power/thermal & performance characteristics



Top Features/Benefits

Strengthen system reliability with a powerful debug and trace tool providing deep hardware and software insight

Analyze and optimize how Intel silicon operates with respect to power

Take advantage of hardware capabilities for optimal system performance on the Intel® platforms

ECOSYSTEM ADOPTION & SUPPORT

Drive adoption of Data Parallel C++ language & oneAPI library APIs

Developer Enabling Programs	oneAPI Zone	Academic Programs & Curriculum	Developer Cloud for latest hardware & software	Development Kits, Reference Architectures	ISV & Application Enabling
Support	Developer Guides, Training & More	Community Forums	Intel Tools Support Forums		
Ecosystem Engagement	Existing Software Standards (OpenMP*, MPI)	Strategic Industry Collaborations	Open Source Community	Third Party Solutions	

ONEAPI AVAILABLE NOW ON INTEL® DEVCLOUD

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

- Use Intel oneAPI Toolkits
- Learn Data Parallel C++
- Evaluate Workloads
- Build Heterogenous Applications
- Prototype your project

NO DOWNLOADS | NO HARDWARE ACQUISITION | NO INSTALLATION | NO SET-UP & CONFIGURATION

GET UP & RUNNING IN SECONDS!

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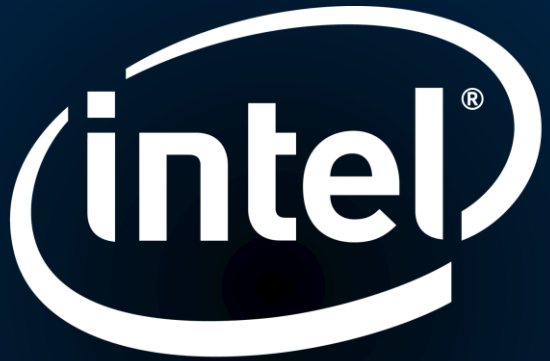
QUESTIONS & ANSWERS



Software