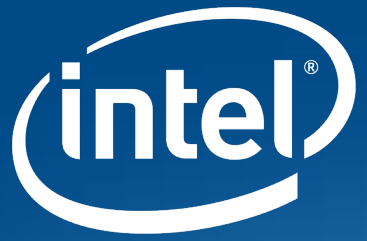

ACCELERATE DEEP LEARNING INFERENCE USING INTEL TECHNOLOGIES

INTRODUCTION: SMART VIDEO

April 2020

SMART VIDEO WORKSHOP OVERVIEW

INTRODUCTION

1. Introduction to Intel technologies for deep learning inference
2. Hardware acceleration techniques

Each module contains a hands-on lab exercise that introduces various Intel technologies to accelerate computer vision application with hardware heterogeneity.

INTEL® DISTRIBUTION OF OPENVINO™ 101

2. Basic End-to-End Object Detection Example

HARDWARE ACCELERATION ON LAPTOP AND DEVCLOUD

3./4./5. Hardware Acceleration with CPU, Integrated GPU, Intel® Movidius™ NCS, FPGA

OPTIMIZATION

6. Optimization Tools and Techniques

APPLICATION

7. Advanced Video Analytics

CUSTOM LAYERS

8. Custom layers

OPTIMIZATION NOTICE

Intel's compilers may or may not optimize to the same degree for non-Intel microprocessors for optimizations that are not unique to Intel microprocessors. These optimizations include SSE2, SSE3, and SSSE3 instruction sets and other optimizations. Intel does not guarantee the availability, functionality, or effectiveness or any optimization on microprocessors not manufactured by Intel. Microprocessor-dependent optimizations in this product are intended for use with Intel microprocessors. Certain optimizations not specific to Intel microarchitecture are reserved for Intel microprocessors. Refer to the applicable product User and Reference Guides for more information regarding the specific instruction sets covered by this notice. Notice Revision #20110804.

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Performance estimates were obtained prior to implementation of recent software patches and firmware updates intended to address exploits referred to as "Spectre" and "Meltdown." Implementation of these updates may make these results inapplicable to your device or system.

Cost reduction scenarios described are intended as examples of how a given Intel-based product, in the specified circumstances and configurations, may affect future costs and provide cost savings. Circumstances will vary. Intel does not guarantee any costs or cost reduction.

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No computer system can be absolutely secure.

Tests document performance of components on a particular test, in specific systems. Differences in hardware, software, or configuration will affect actual performance. Consult other sources of information to evaluate performance as you consider your purchase. For more complete information about performance and benchmark results, visit www.intel.com/performance.

Cost-reduction scenarios described are intended as examples of how a given Intel-based product, in the specified circumstances and configurations, may affect future costs and provide cost savings. Circumstances will vary. Intel does not guarantee any costs or cost reduction.

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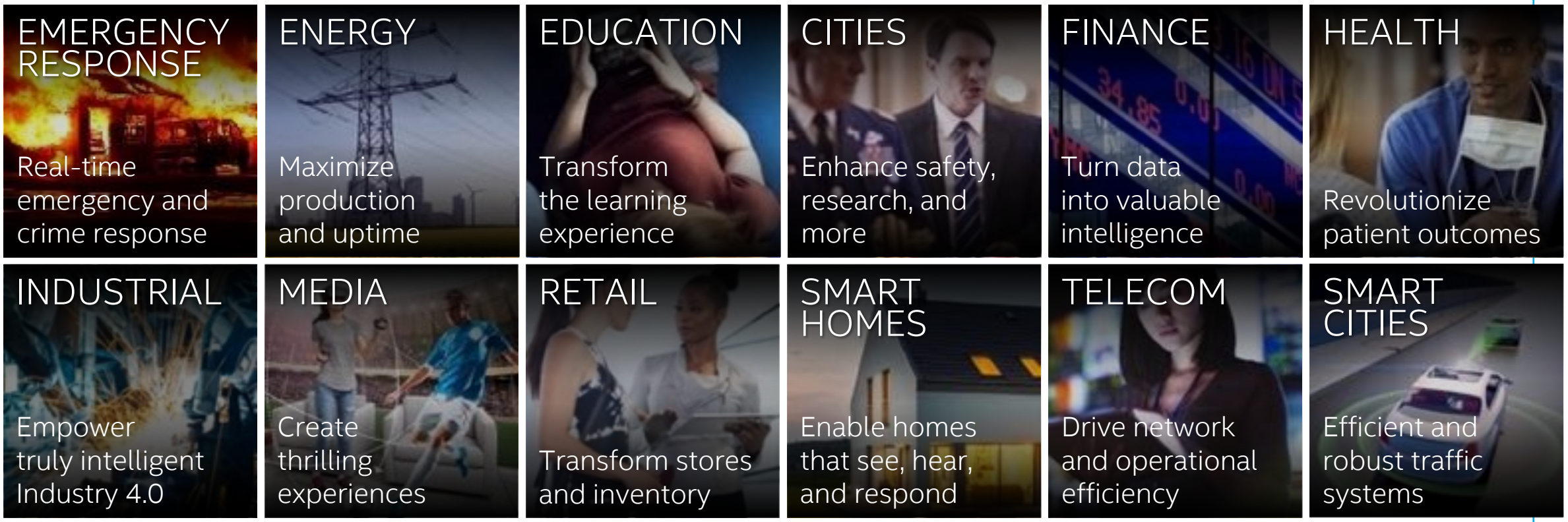
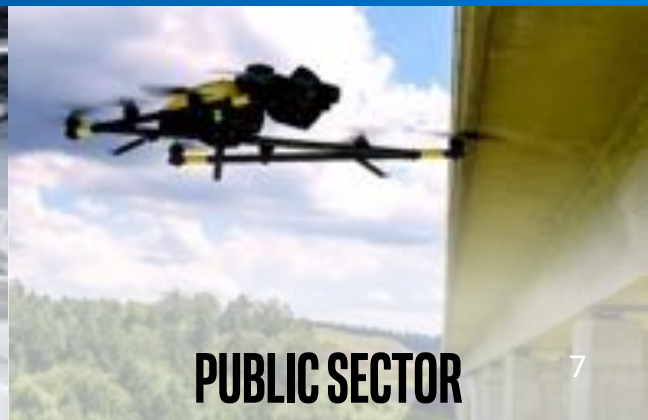
AI IS CHANGING EVERY MARKET



VIDEO: THE "EYE OF IOT"

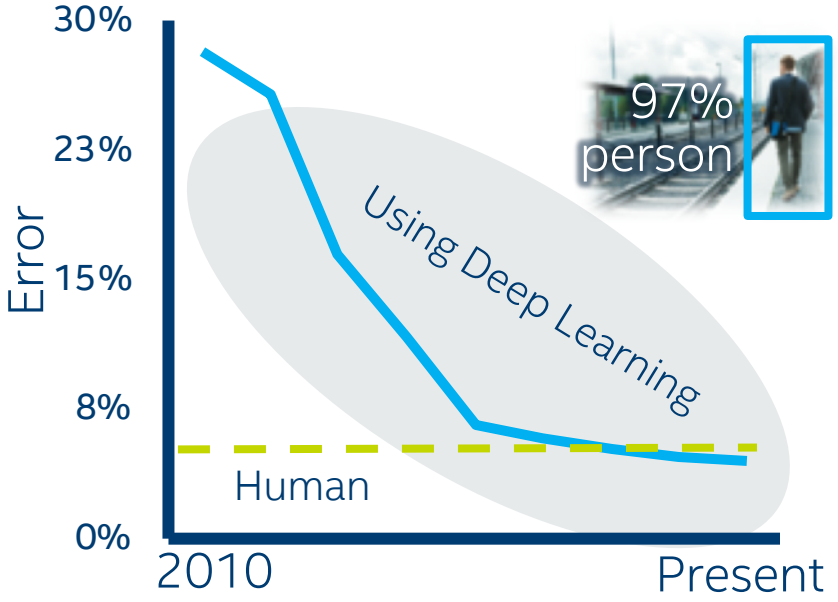
USE OF VIDEO, COMPUTER VISION AND DEEP LEARNING IS GROWING RAPIDLY



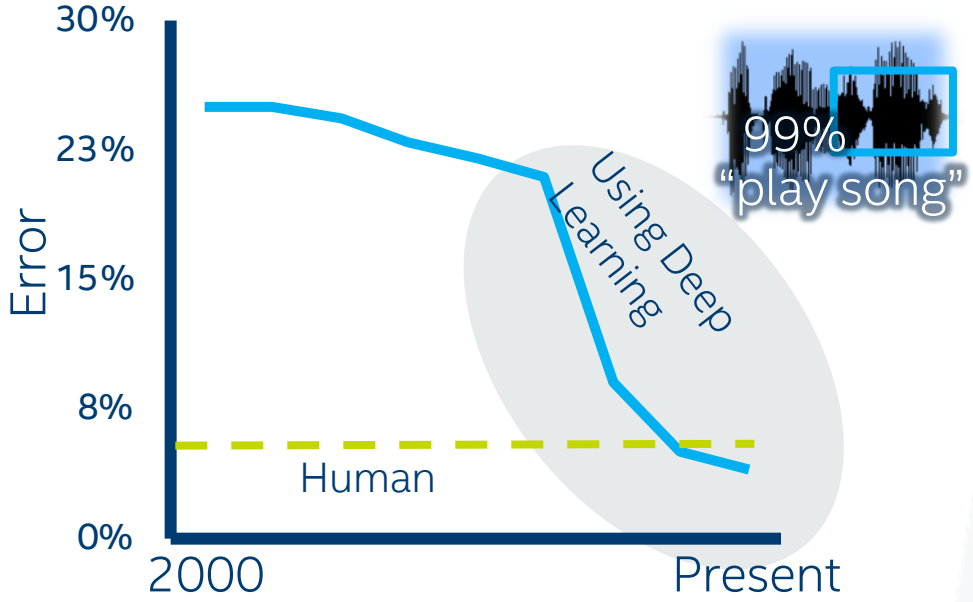
DEEP LEARNING BREAKTHROUGHS AND OPPORTUNITIES

Machines able to meet or exceed human image and speech recognition

Image Recognition



Speech Recognition



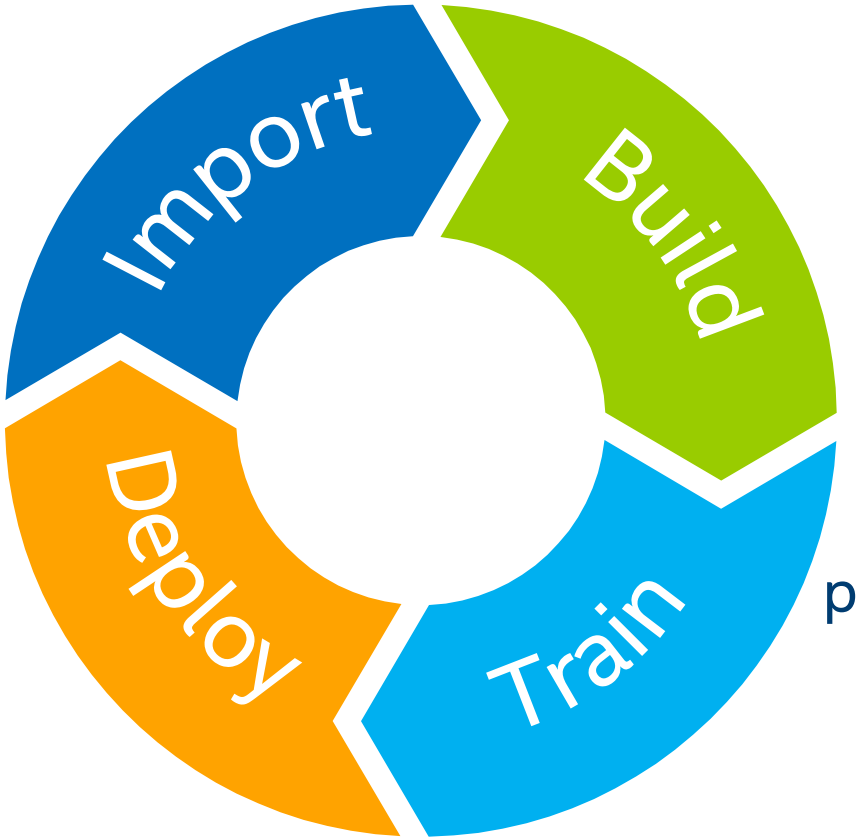
ADDITIONAL ECONOMIC IMPACT DRIVEN BY AI
$13 TRILLION IN 2030

Source: ILSVRC ImageNet winning entry classification error rate each year 2010-2016 (Left), https://www.microsoft.com/en-us/research/blog/microsoft-researchers-achieve-new-conversational-speech-recognition-milestone/ (Right)
Source: https://www.mckinsey.com/featured-insights/artificial-intelligence/notes-from-the-ai-frontier-applications-and-value-of-deep-learning

DEEP LEARNING DEVELOPMENT CYCLE

Data acquisition and organization

Create models



Integrate trained models with application code

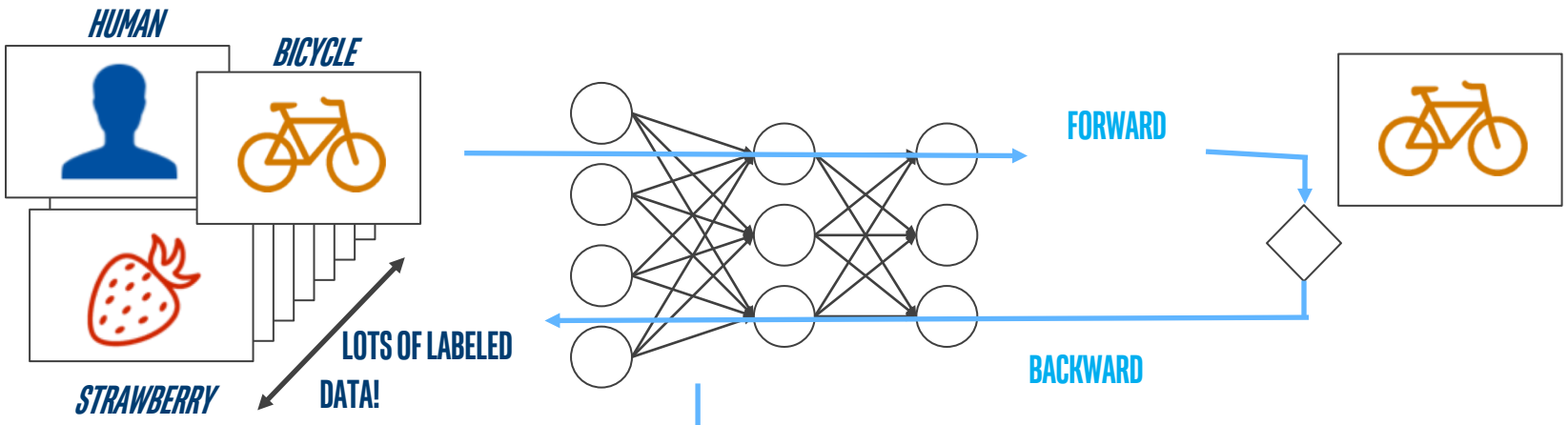
Adjust models to meet performance and accuracy objectives

Intel® Distribution OpenVINO™ Toolkit Provides Deployment from Intel® Edge to Cloud

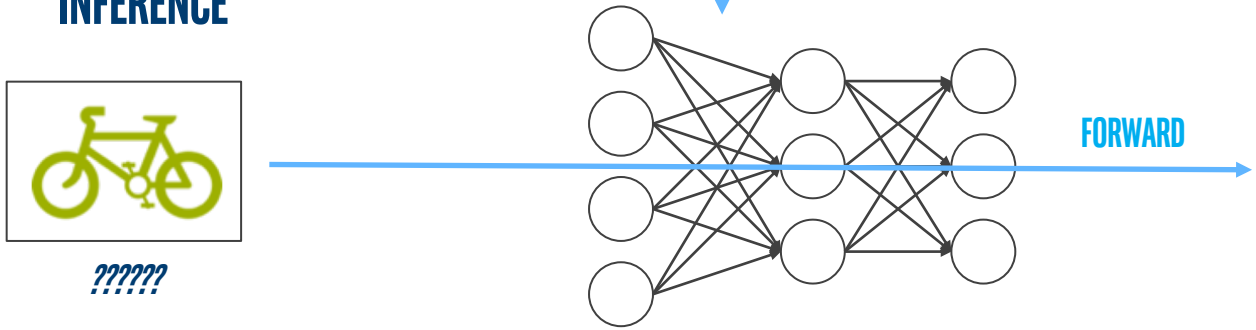
intel

DEEP LEARNING: TRAINING VS. INFERENCE

TRAINING

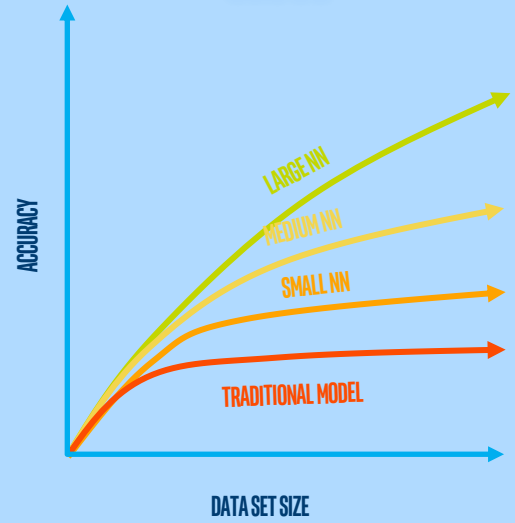


INFERENCE

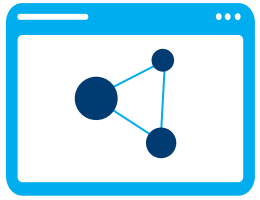


DID YOU KNOW?

Training requires a very large data set and deep neural network (many layers) to achieve the highest accuracy in most cases



THE CHALLENGES IN DEPLOYING DEEP LEARNING



Unique Inference Needs

Gap in performance and accuracy between trained and deployed models

Low performing, lower accuracy models deployed

Integration Challenges

No streamlined way for end-to-end development workflow

Slow time-to-solution and time–to-market

No One Size Fits All

Diverse requirements for myriad use cases require unique approaches

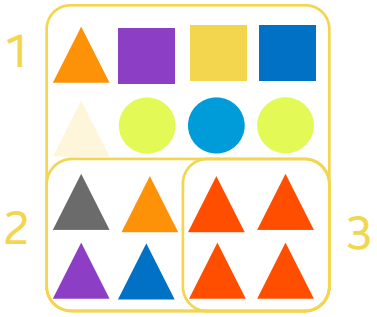
Inability to meet use-case specific requirements

OpenVINO

AI COMPUTE CONSIDERATIONS

How do you determine the right computing for your AI needs?

WORKLOADS

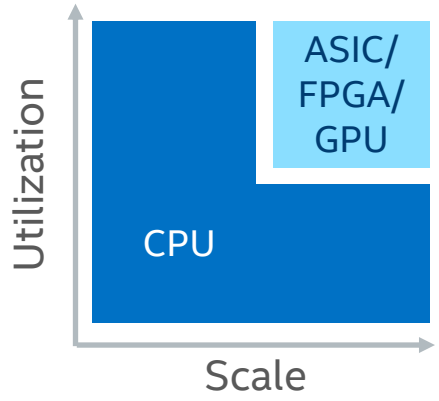


What is my workload profile?

REQUIREMENTS

What are my use case requirements?

DEMAND

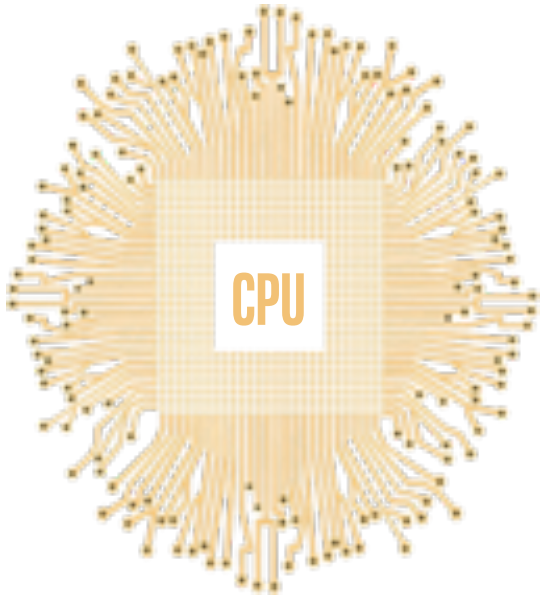


How prevalent is AI in my environment?

OpenVINO

WHY INTEL AI COMPUTE?

MAXIMIZE

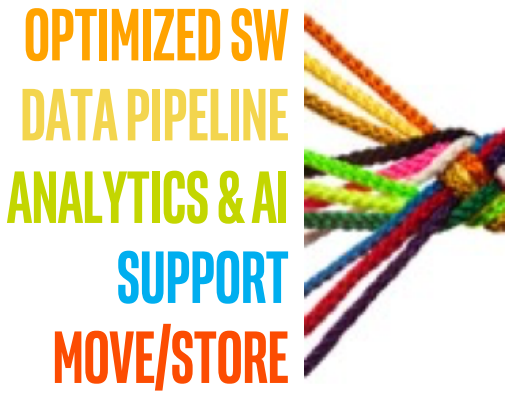


Get the most out of the foundation for AI from the CPU leader

OPTIMIZE

Choose the right compute for you from the one with all the options

SIMPLIFY



Reduce “moving parts” by building on an optimized AI platform

LEAD

Lead your industry by aligning with the builder of next-gen AI solutions

INTEL® DISTRIBUTION OF OPENVINO™ TOOLKIT

Tool Suite for High-Performance, Deep Learning Inference

Faster, more accurate real-world results using high-performance, AI and computer vision inference deployed into production across Intel® architecture from edge to cloud

High-Performance,
Deep Learning Inference

Streamlined Development,
Ease of Use

Write Once,
Deploy Anywhere

THE COMPOUNDING EFFECT OF BOTH HARDWARE AND SOFTWARE

Improvements Means Exponential Performance

For more complete information about performance and benchmark results, visit www.intel.com/benchmarks. See backup for configuration details.
Comparison of Frames Per Second utilizing Mobilenet SSD, Batch 1.


DEPLOY DEEP LEARNING SOLUTIONS WITH INTEL® DISTRIBUTION OF OPENVINO™ TOOLKIT
1. BUILD
2. OPTIMIZE
3. DEPLOY

1. BUILD

2. OPTIMIZE

3. DEPLOY

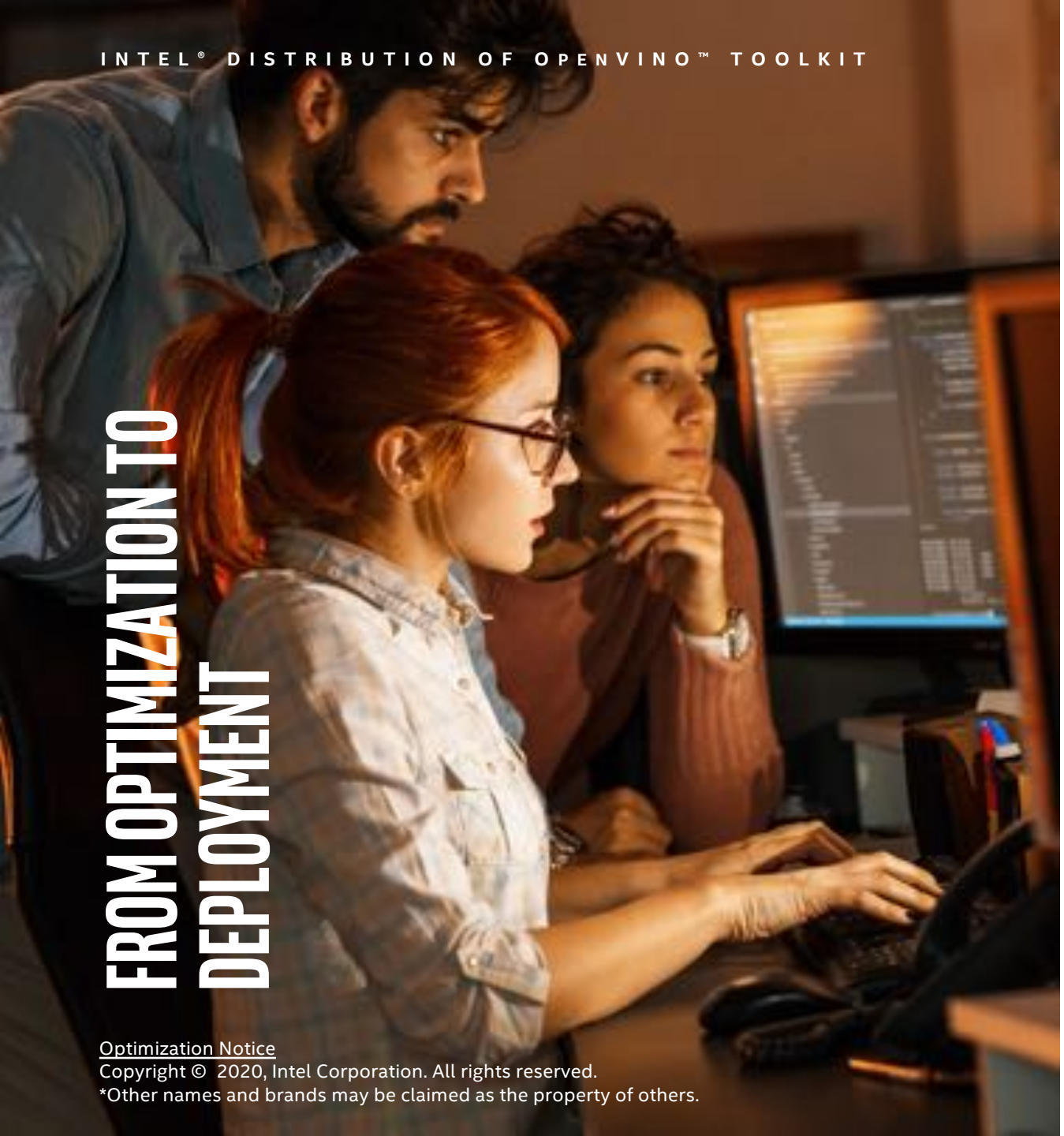
BREADTH OF SUPPORTED FRAMEWORKS MAXIMIZES DEVELOPMENT

Supported Frameworks and Formats ▸ https://docs.openvinotoolkit.org/latest/_docs_IE_DG_Introduction.html#SupportedFW
Configure the Model Optimizer for your Framework ▸ https://docs.openvinotoolkit.org/latest/_docs_MO_DG_prepare_model_Config_Model_Optimizer.html

1. BUILD

2. OPTIMIZE

3. DEPLOY



FROM OPTIMIZATION TO DEPLOYMENT

OpenVINO

Model Optimizer

- A Python-based tool to import trained models and convert them to Intermediate Representation
- Optimizes for performance or space with conservative topology transformations
- Hardware-agnostic optimizations

Development Guide
https://docs.openvinotoolkit.org/latest/_docs_MO_DG_Deep_Learning_Model_Optimizer_DevGuide.html

Inference Engine

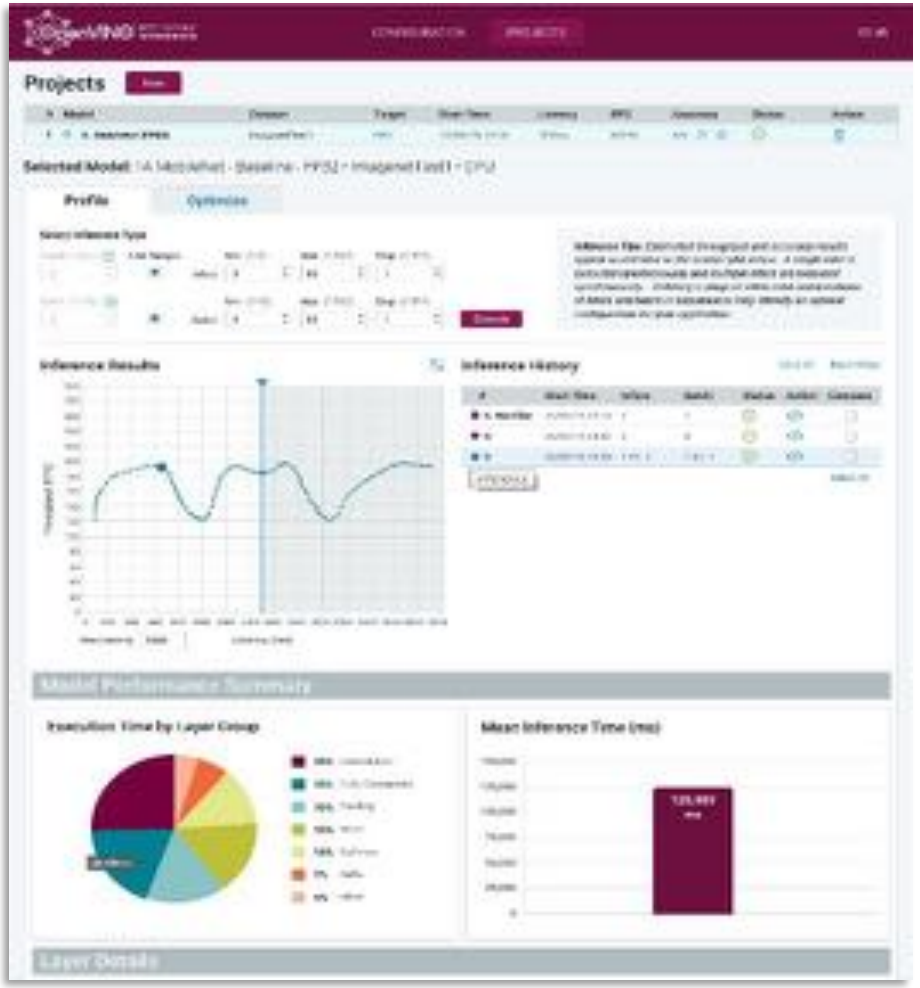
- High-level, C/C++ and Python, inference API
- Interface is implemented as dynamically loaded plugins for each hardware type
- Delivers best performance for each type without requiring users to implement and maintain multiple code pathways

Development Guide
https://docs.openvinotoolkit.org/latest/_docs_IE_DG_Deep_Learning_Inference_Engine_DevGuide.html

OpenVINO

Deep Learning Workbench

- Web-based, UI extension tool of the Intel® Distribution of OpenVINO™ toolkit
- Visualizes performance data for topologies and layers to aid in model analysis
- Automates analysis for optimal performance configuration (streams, batches, latency)
- Experiment with int8 or Winograd calibration for optimal tuning
- Provide accuracy information through accuracy checker
- Direct access to models from public set of Open Model Zoo

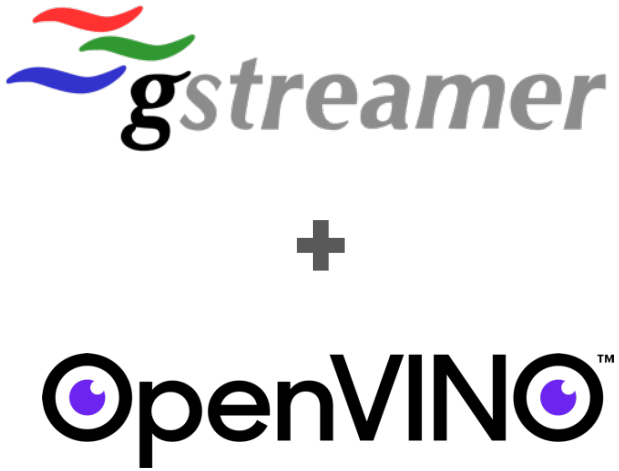


Development Guide
https://docs.openvinotoolkit.org/latest/_docs_Workbench_DG_Introduction.html

Deep Learning Streamer

- Intel® Distribution of OpenVINO™ toolkit **Deep Learning (DL) Streamer**, now part of the default installation package
- Enables developers to **create and deploy** optimized streaming media analytics pipelines across Intel® architecture from edge to cloud
- Optimal pipeline interoperability with a familiar developer experience built using the **GStreamer*** multimedia framework

Learn More
https://docs.openvinotoolkit.org/latest/index.html#toolkit_components



1. BUILD

2. OPTIMIZE

3. DEPLOY

WRITE ONCE, DEPLOY ANYWHERE

Cross-Platform Flexibility on Intel® Distribution of OpenVINO™ toolkit

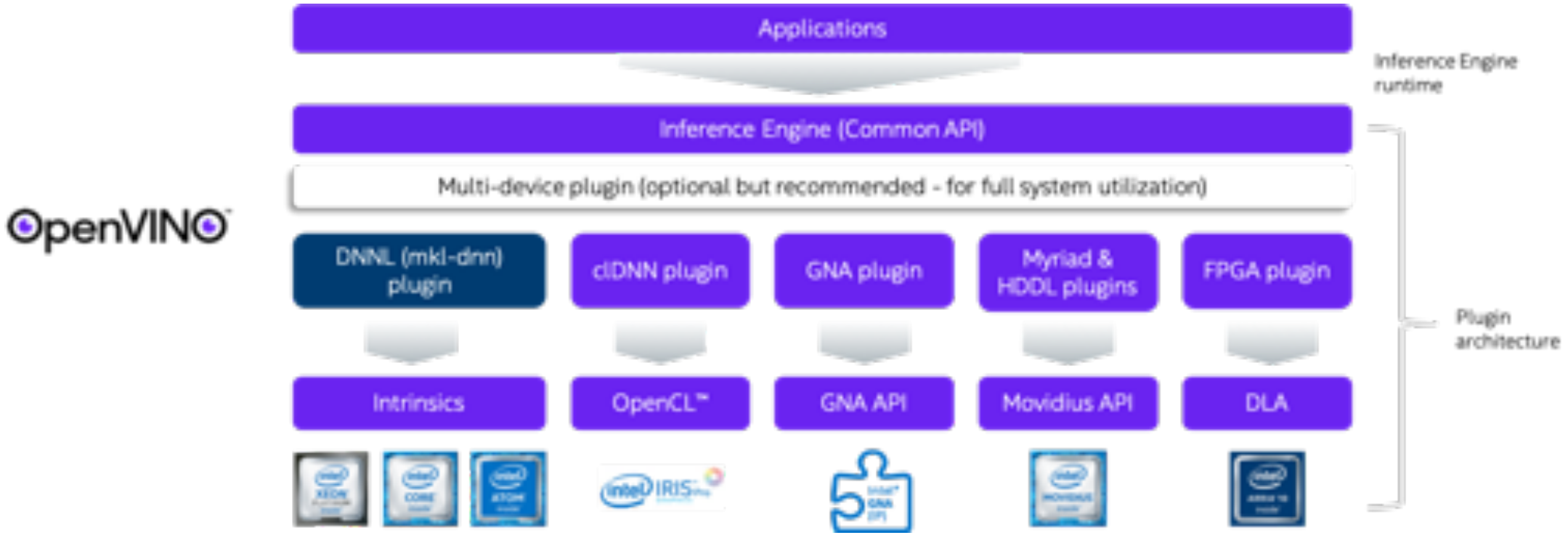
Write once, deploy across different platforms with the same API and framework-independent execution

Consistent accuracy, performance and functionality across all target devices with no re-training required

[NEW] Full environment utilization, or multi-device plugin, across available hardware for greater performance results

Introduction ▸ https://docs.openvinotoolkit.org/latest/_docs_IE_DG_supported_plugins_HETERO.html

INTEL® DISTRIBUTION OF OPENVINO™ TOOLKIT
WRITE ONCE, DEPLOY ANYWHERE



OpenVINO

TOOLS TO SPEED UP TEST CYCLES AND DEVELOPMENT

[NEW] Post-training Optimization

- Reduce model size into low precision data types, such as INT8
- Reduces model size while also improving latency

Deployment Manager

- Generate an optimal, minimized runtime package for deployment
- Deploy with smaller footprint compared to development package

Model Analyzer

- Provides theoretical data on models: computational complexity (flops), number of neurons, memory consumption

Accuracy Checker

- Check for accuracy of the model (original and after conversion) to IR file using a known data set

Benchmark App

- Measure performance (throughput, latency) of a model
- Get performance metrics per layer and overall basis

Model Downloader

- Provides an easy way of accessing a number of public models as well as a set of pre-trained Intel models

Get Started ▸ https://docs.openvinotoolkit.org/latest/_docs_IE_DG_Tools_Overview.html –or- by using the Deep Learning Workbench

OpenVINO

SPEED UP DEVELOPMENT USING THE OPEN MODEL ZOO

Open source resources with pre-trained models, samples and demos

Computer Vision

Object detection

Object recognition

Reidentification

Semantic segmentation

Instance segmentation

Human pose estimation

Image processing

Audio, Speech, Language

Text detection

Text recognition

Recommender

Action recognition

Other

(Data Generation, Reinforcement Learning)

Compression models

Image retrieval

And more..

PRE-TRAINED MODELS

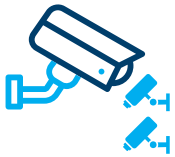
https://github.com/opencv/open_model_zoo

SPEED UP DEVELOPMENT USING THE OPEN MODEL ZOO

Open source resources with pre-trained models, demos, and tools

The Open Model Zoo demo applications are console applications that demonstrate how you can use your applications to solve specific use-cases.

Smart Classroom
Recognition and action detection demo for classroom settings



Multi-Camera, Multi-Person
Tracking multiple people on multiple cameras for public safety use cases

Gaze Estimation
Face detection followed by gaze estimation, head pose estimation and facial landmarks regression.

Super Resolution
Enhances the resolution of the input image

Action Recognition
Classifies actions that are being performed on input video

And more..

DEMO APPLICATIONS
https://github.com/opencv/open_model_zoo

TEST HARDWARE WITH THE INTEL® DEVCLOUD FOR THE EDGE

Powered by Intel® Distribution of OpenVINO™ toolkit

Trained Model
Model trained using one of the supported frameworks

-or-

Using a pre-trained model available from the Open Model Zoo

Intel® Distribution of OpenVINO™ toolkit
Model Optimizer
Inference Engine

Intel® DevCloud for the Edge
A development sandbox to try AI and vision workloads remotely before purchasing Intel® platforms

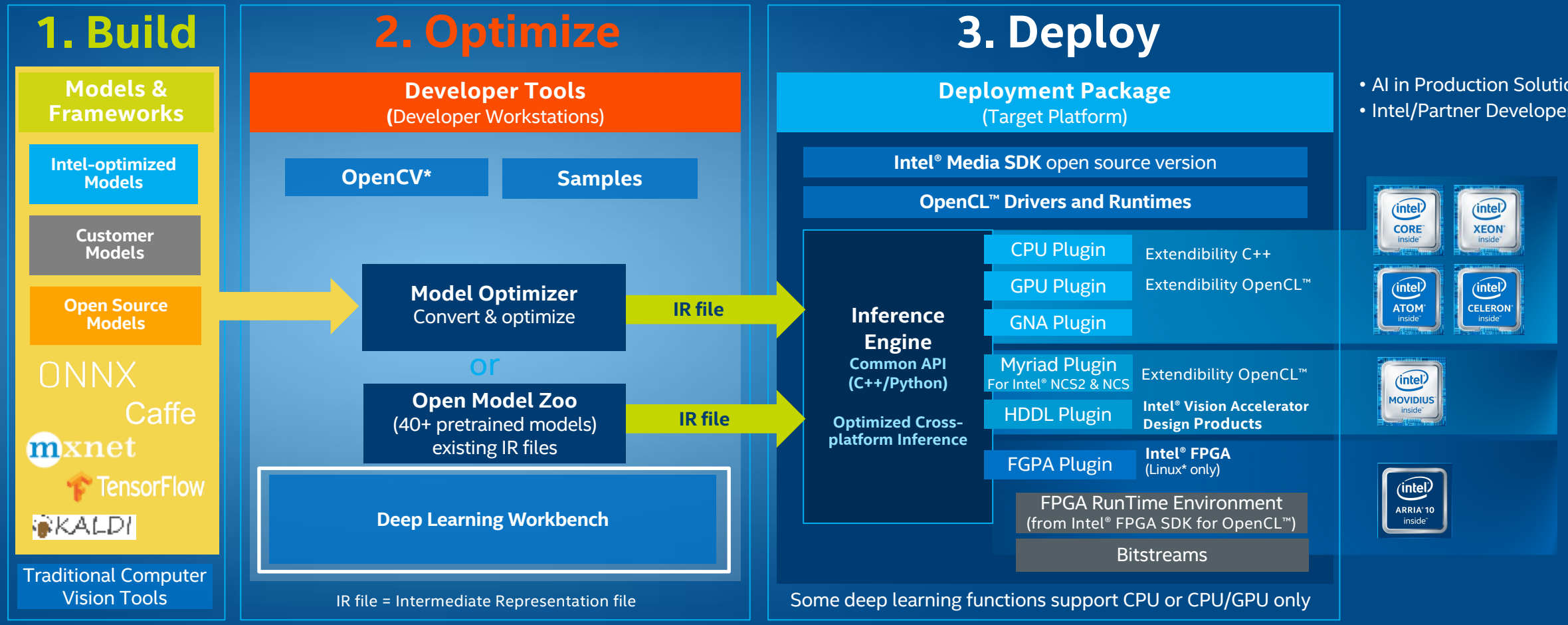
- Prototype on the latest hardware and software to future proof your solution
- Benchmark your customized AI application
- Run AI applications from anywhere in the world
- Reduce development time and cost

https://devcloud.intel.com/edge/

Deploy and Scale

USING THE INTEL® DISTRIBUTION OF OPENVINO™ TOOLKIT

ADVANCED CAPABILITIES TO STREAMLINE DEEP LEARNING DEPLOYMENT



Intel® NCS = Intel® Neural Compute Stick (VPU)

THE COMPOUNDING EFFECT IN PRODUCTION DEPLOYMENTS

Powered by the Intel® Distribution of OpenVINO™ toolkit

Improvements made by pairing together Intel® architecture-based systems and deep learning acceleration powered by the Intel® Distribution of OpenVINO™ toolkit

Defect Detection

Aluminum alloy die-casting factories improved defect detection accuracy 5X from manual detection to automatic detection. Learn more

Cardiac Examination

Cardiac magnetic resonance imaging (MRI) exams to evaluate heart function, heart chamber volumes and myocardial tissue accelerated by 5.5X. Learn more

Medical Imaging

Medical imaging accelerated bone age prediction model by 188X and lung segmentation model by 38X in inference performance. Learn more

Cities Traffic Management

Thailand's Ministry of Transportation saw reduction of avg queue length by 30.5% & reductions in delay by 8.46-24.52% in intersections in Bangkok. Learn more

Operational Improvement

11X increase in performance on Intel® architecture and 19X with Intel® Vision Accelerator that lead to operational improvements in manufacturing. Learn more

Autonomous Sea Navigation

Autonomous and assisted sea navigation for autonomous ships delivered 4.8X image throughput compared to unoptimized baseline. Learn more

Success Stories ▶ https://intel.com/openvino-success-stories

INTEL® MEDIA SDK

API to Access Intel® Quick Sync Video: Hardware Accelerated Encoding, Decoding, and Processing

- H.265 (HEVC)
- H.264 (AVC)
- MPEG-2 and more
- Resize, scale, deinterlace
- Color conversion, composition
- Denoise, sharpen, and more

Benefits

- Outstanding performance
- Rich API to tune encoding pipeline
- Future proofed: support new processor without code changes

Targeting Digital Security and Surveillance, Connected Car Applications, and More

Smart Camera

Car Infotainment and Cluster Display

using

Intel Atom®, Pentium®, and Celeron® [1]

and

Embedded Linux*

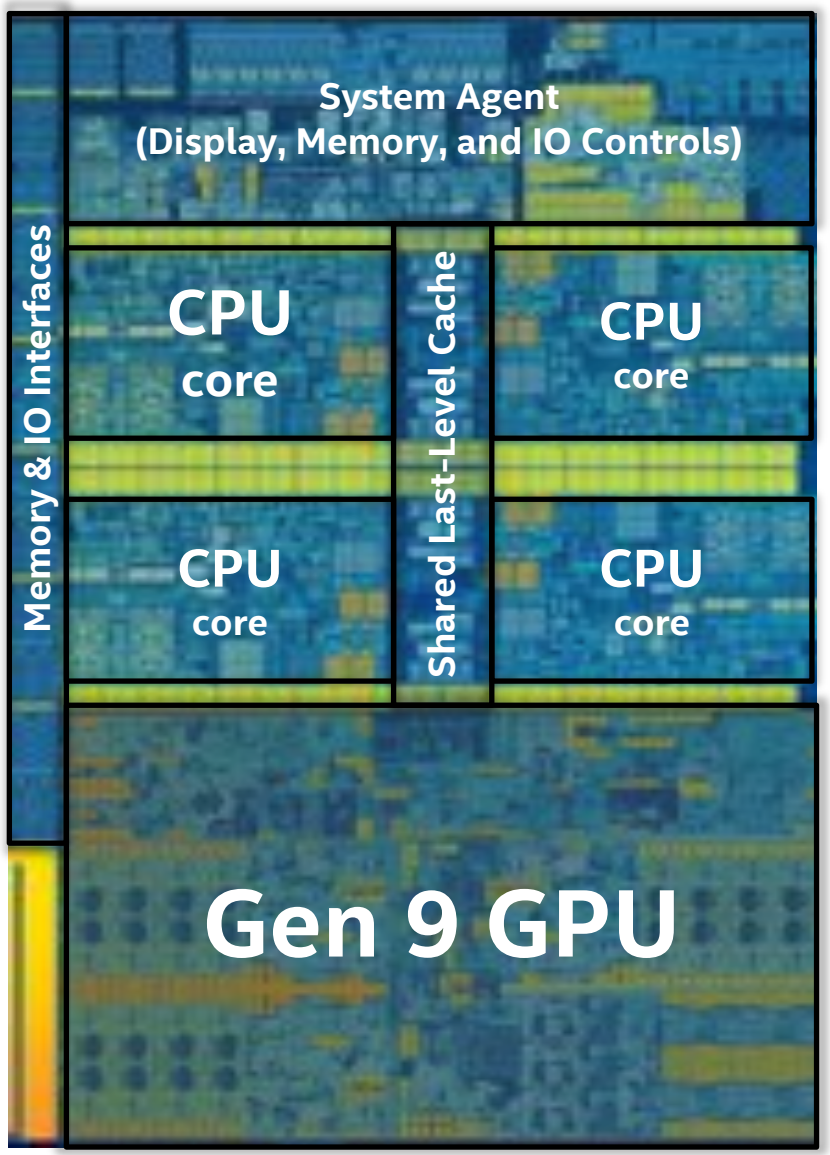
yocto PROJECT

[1] Intel® Celeron® Processor N3350, Intel® Pentium® Processor N4200, Intel Atom® E3930, E3940, E3950 processors

INTEL INTEGRATED GRAPHICS

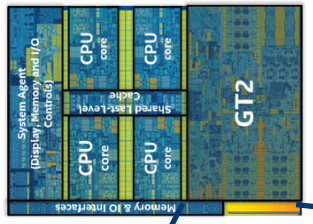
Gen is the internal name for Intel's on-die GPU solution. It's a hardware ingredient with various configurations.

- Intel® Core™ Processors include Gen hardware.
- Gen GPUs can be used for graphics and also as general compute resources.
- Libraries contained in the Intel® Distribution of OpenVINO™ toolkit (and many others) support Gen offload using OpenCL™.



6th Generation Intel® Core™ i7 (Skylake) Processor

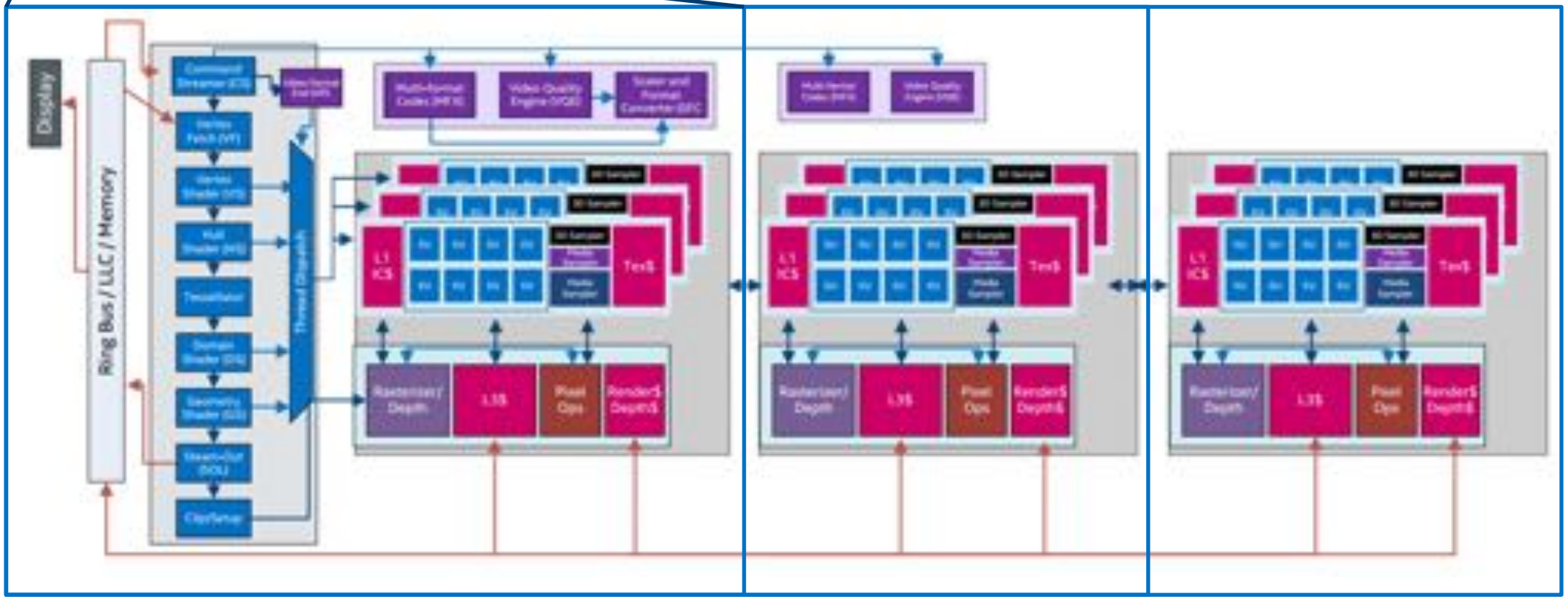
INTEL GPU CONFIGURATIONS



GT2
Intel® HD Graphics
24 EUs, 1 MFX

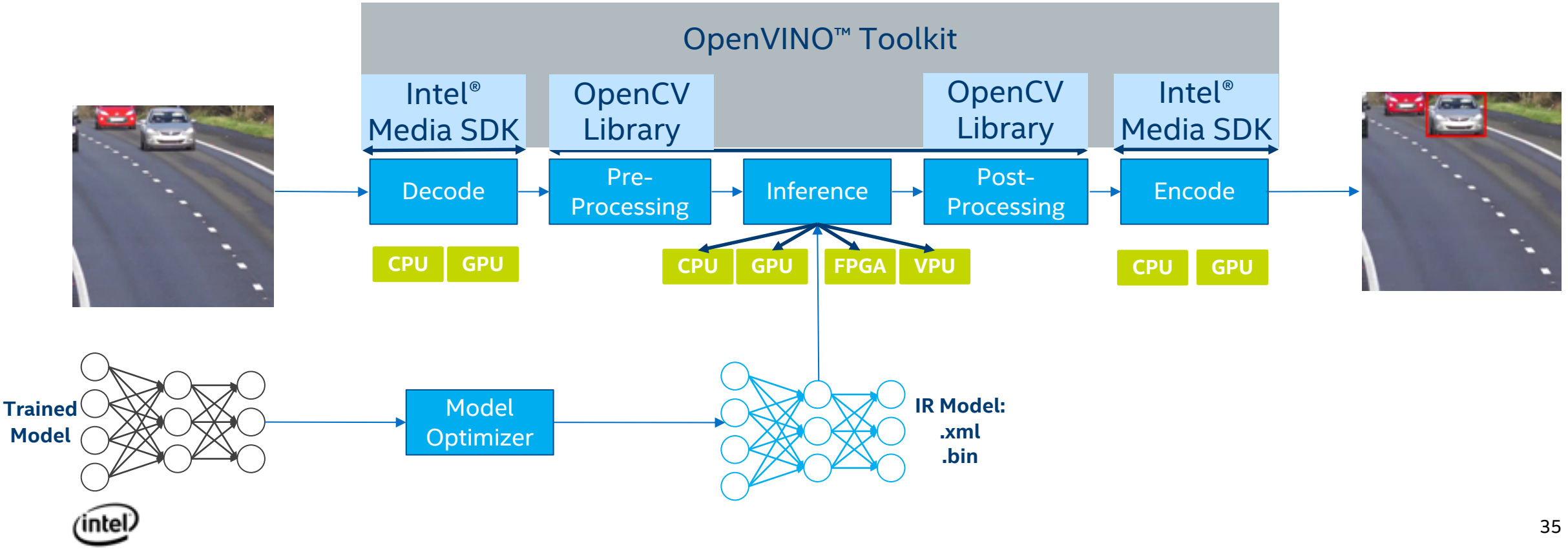
GT3
Intel® Iris® Graphics
48 EUs, 2 MFX

GT4
Intel® Iris® Pro Graphics
72 EUs, 2 MFX



Workflow of Applying OpenVINO™ in CV Applications, Accelerate Streaming Performance

Using Intel® Media SDK and the OpenVINO™ toolkit together enables customers to build high performance, intelligent vision solutions.



GETTING STARTED WITH INTEL® DISTRIBUTION OF OPENVINO™ TOOLKIT

Recommendations to the customer or developer

QUALIFY

- Use a trained model and check if framework is supported

  - *or* –

- Take advantage of a pre-trained model from the Open Model Zoo

INSTALLATION

- Download the Intel® OpenVINO™ toolkit package from Intel® Developer Zone, or by YUM or APT repositories
- Utilize the Getting Started Guide

PREPARE

- Understand sample demos and tools included
- Understand performance
- Choose hardware option with Performance Benchmarks
- Build, test and remotely run workloads on the Intel® DevCloud for the Edge before buying hardware

HANDS ON

- Visualize metrics with the Deep Learning Workbench
- Utilize prebuilt, Reference Implementations to become familiar with capabilities
- Optimize workloads with these performance best practices
- Use the Deployment Manager to minimize deployment package

SUPPORT

- Ask questions and share information with others through the Community Forum
- Engage using #OpenVINO on Stack Overflow
- Visit documentation site for guides, how to's, and resources
- Attend training and get certified

JUMPSTART DEEP LEARNING TODAY!

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Intel® Distribution of OpenVINO™ toolkit

Also available from
Docker | YUM | APT | [NEW] Anaconda Cloud


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