

ACCELERATE DEEP LEARNING INFERENCE USING INTEL TECHNOLOGIES

INTRODUCTION: SMART VIDEO

November 2018

Core and Visual Computing Group

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No computer system can be absolutely secure.

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EMERGENCY RESPONSE



FINANCIAL SERVICES



MACHINE VISION



CITIES/TRANSPORTATION

VIDEO: THE “EYE OF IOT”

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



AUTONOMOUS VEHICLES



RESPONSIVE RETAIL



MANUFACTURING

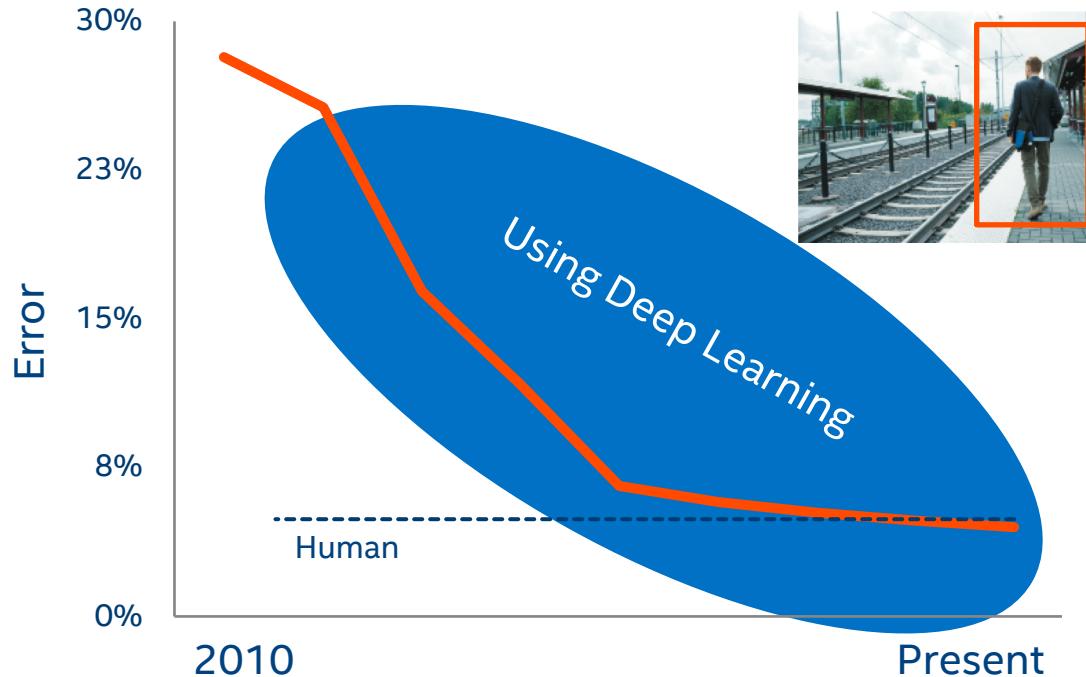


PUBLIC SECTOR

Deep Learning Usage Is Increasing

Deep learning revenue is estimated to grow from \$655M in 2016 to **\$35B** by 2025¹.

Image Recognition



Traditional Computer Vision Object Detection



Deep Learning Computer Vision Person Recognition

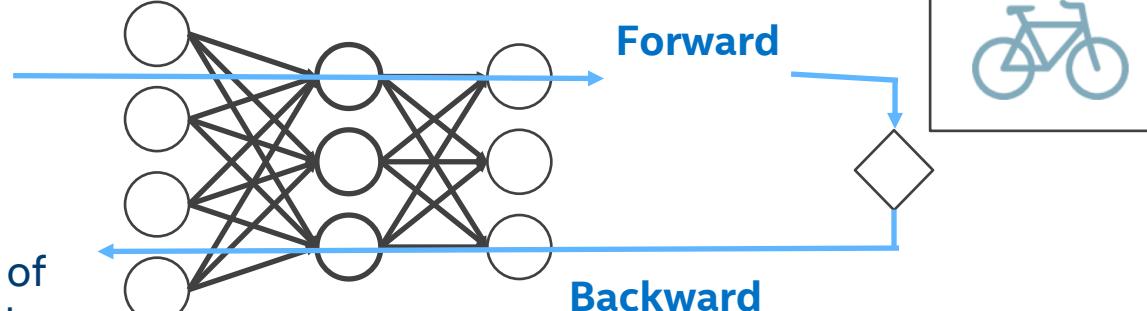
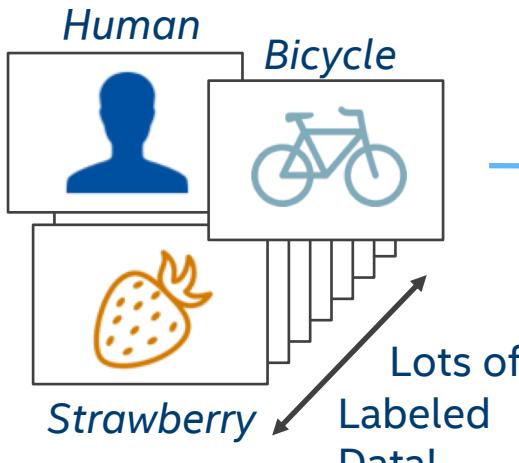


Market Opportunities + Advanced Technologies Have Accelerated Deep Learning Adoption

¹Tractica* 2Q 2017

Deep Learning: Training vs. Inference

Training

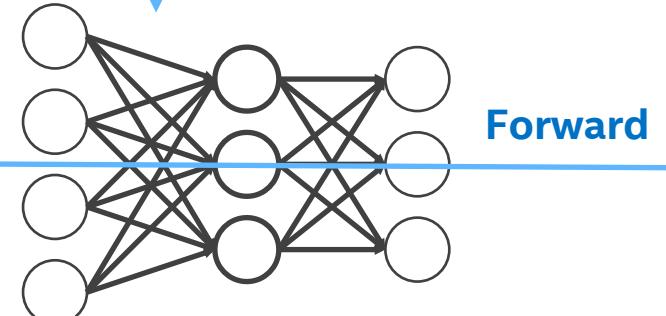


Model Weights

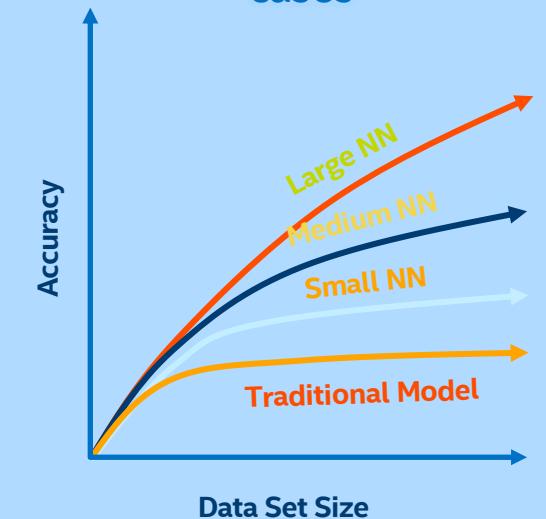
Inference



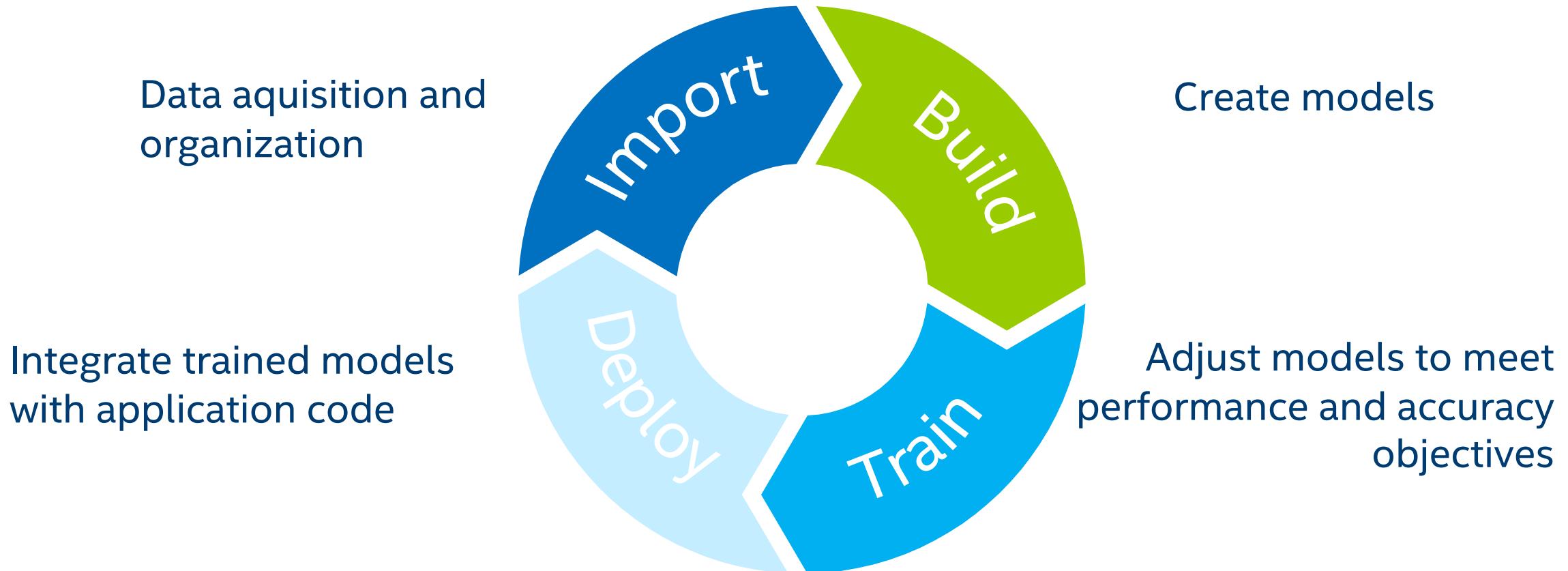
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Training requires a very large data set and deep neural network (many layers) to achieve the highest accuracy in most cases



Artificial Intelligence Development Cycle

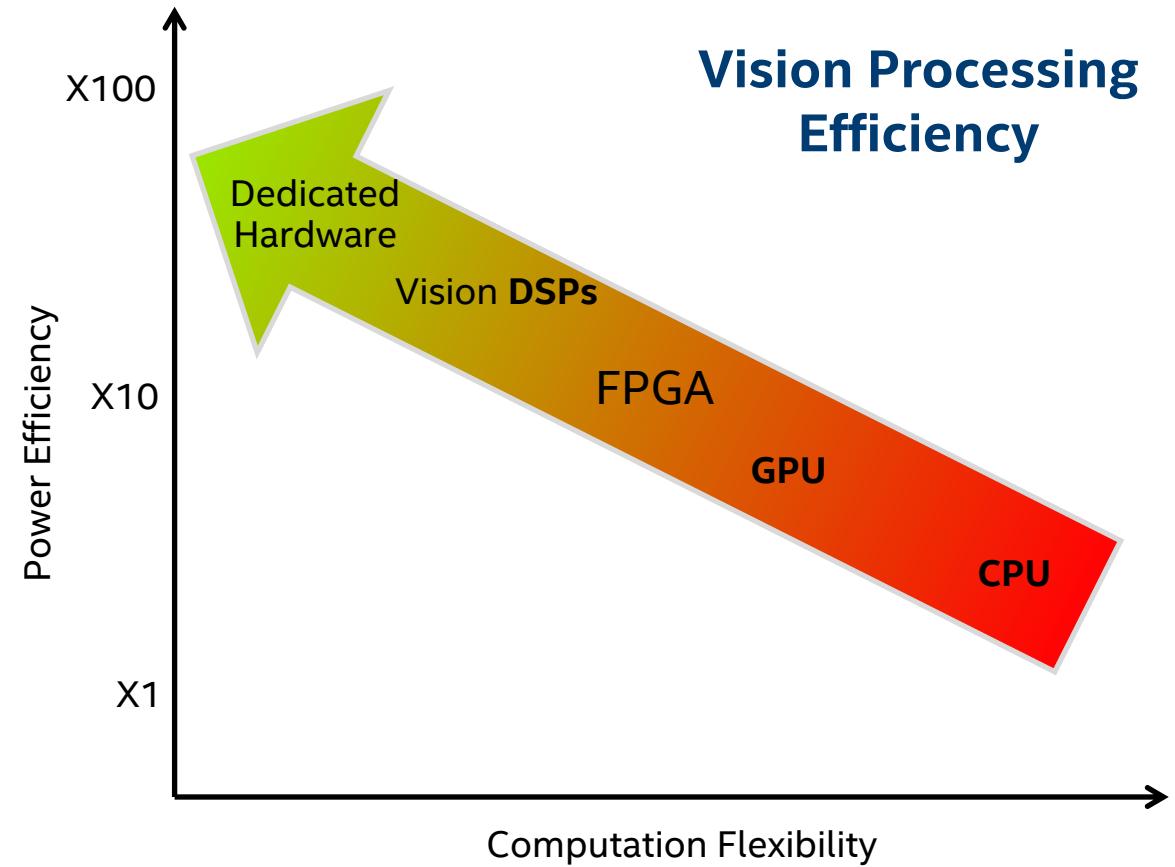


Intel® Deep Learning Deployment Toolkit Provides Deployment from Intel® Edge to Cloud

Choosing the “Right” Hardware

Power/Performance Efficiency Varies

- Running the right workload on the right piece of hardware → higher efficiency
- Hardware acceleration is a must
- Heterogeneous computing?



Tradeoffs

- Power/performance
- Price
- Software flexibility, portability

Intel Computer Vision Portfolio

EXPERIENCES



TOOLS

Intel® Parallel Studio XE
Intel® System Studio
Intel® SDK for OpenCL™ Applications

Intel® Media SDK / Media Server Studio
Intel® Distribution of OpenVINO™ toolkit

FRAMEWORKS



theano



Caffe



ONNX

LIBRARIES

Intel® Data
Analytics
Acceleration
Library

Intel®
Distribution for python

Intel® Math Kernel Library

Intel® Nervana™ Graph



Movidius Stack

HARDWARE



Compute



Memory & Storage



Networking



Visual Intelligence

UNLEASH
FULL
POTENTIAL

What's Inside Intel® Distribution of OpenVINO™ toolkit

Intel® Deep Learning Deployment Toolkit

Model Optimizer

Convert & Optimize



Inference Engine

Optimized Inference

30+ Pre-trained
Models

Computer Vision
Algorithms

Samples

IR = Intermediate Representation file



Traditional Computer Vision

Optimized Libraries & Code Samples

OpenCV*

OpenVX*

Samples

For Intel® CPU & GPU/Intel® Processor Graphics

Tools & Libraries

Increase Media/Video/Graphics Performance

Intel® Media SDK

Open Source version

OpenCL™

Drivers & Runtimes

For GPU/Intel® Processor Graphics

Optimize Intel® FPGA (Linux* only)

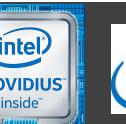
FPGA RunTime Environment

(from Intel® FPGA SDK for OpenCL™)

Bitstreams

OS Support: CentOS* 7.4 (64 bit), Ubuntu* 16.04.3 LTS (64 bit), Microsoft Windows* 10 (64 bit), Yocto Project* version Poky Jethro v2.0.3 (64 bit)

Intel® Architecture-Based
Platforms Support



Intel® Vision Accelerator
Design Products &
AI in Production/
Developer Kits

An open source version is available at 01.org/openvino (some deep learning functions support Intel CPU/GPU only).

Benefits of Intel® Distribution of OpenVINO™ toolkit

Maximize the Power of Intel® Processors: CPU, GPU/Intel® Processor Graphics, FPGA,VPU

 ACCELERATE PERFORMANCE	 INTEGRATE DEEP LEARNING
<p>Access Intel computer vision accelerators. Speed code performance. Supports heterogeneous execution.</p>	<p>Unleash CNN-based deep learning inference using a common API, 30+ pre-trained models, & computer vision algorithms. Validated on more than 100 public/custom models.</p>
 SPEED DEVELOPMENT	 INNOVATE & CUSTOMIZE
<p>Reduce time using a library of optimized OpenCV* & OpenVX* functions, & 15+ samples. Develop once, deploy for current & future Intel-based devices.</p>	<p>Use OpenCL™ kernels/tools to add your own unique code. Customize layers without the overhead of frameworks.</p>

Deep learning revenue is estimated to grow from \$655M in 2016 to **\$35B** by 2025¹.

¹Tractica 2Q 2017

OpenVINO™ Toolkit

Open Source Version



- Provides flexibility and availability to the developer community to extend OpenVINO™ toolkit for custom needs
- Components that are open sourced
 - Deep Learning Deployment Toolkit with CPU, GPU & Heterogeneous plugins
github.com/openvino/dldt
 - Open Model Zoo - Includes pre-trained models, model downloader, demos and samples - github.com/openvino/open_model_zoo
- See [FAQ](#) & next slide for key differences between the open source & Intel distribution versions



More details ► 01.org/openvinotoolkit

Quick Guide: What's Inside the Intel Distribution vs Open Source version of OpenVINO™ toolkit

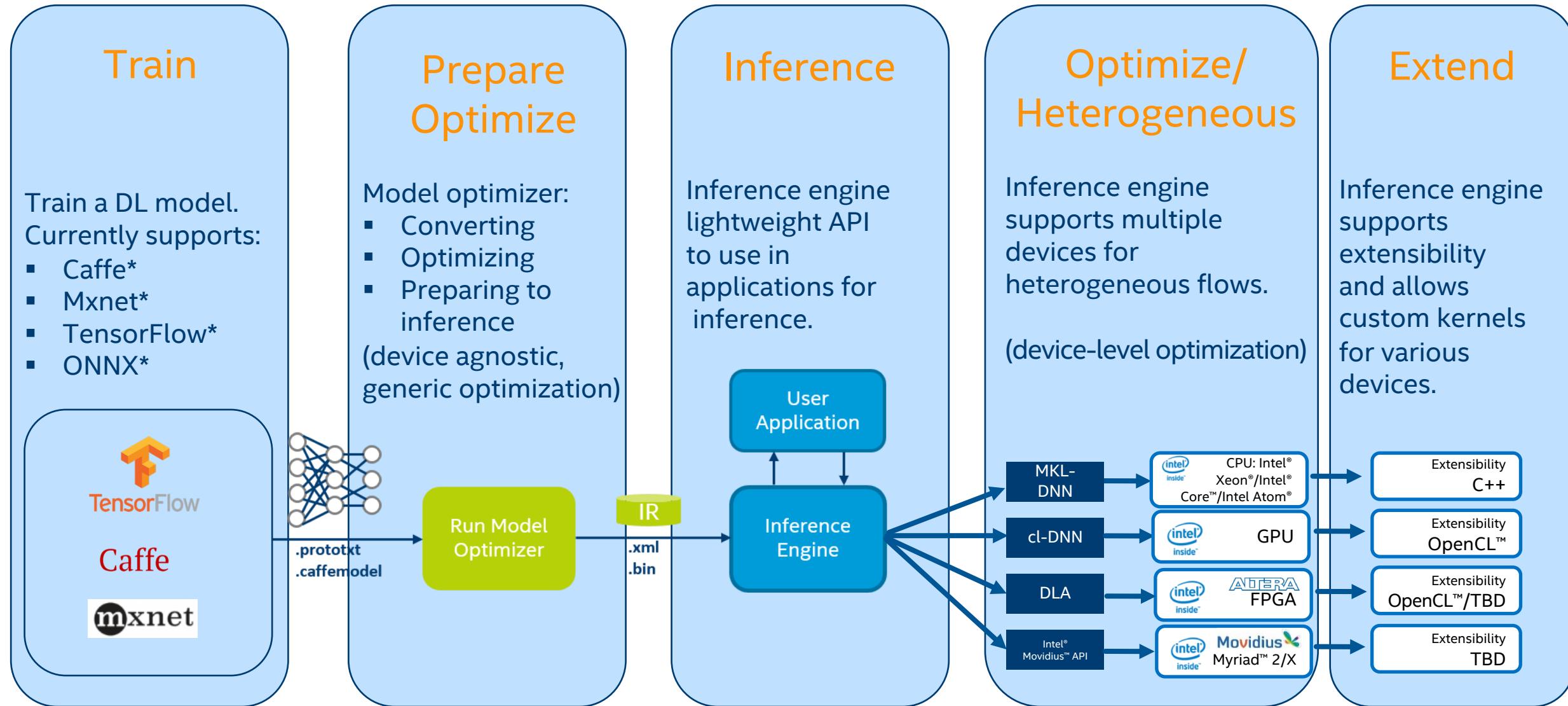
Tool/Component	Intel® Distribution of OpenVINO™ toolkit	OpenVINO™ toolkit (open source)	Open Source Directory
Installer (including necessary drivers)	✓		
Intel® Deep Learning Deployment toolkit			
Model Optimizer	✓	✓	/opencv/dldt/tree/2018/model-optimizer
Inference Engine	✓	✓	/opencv/dldt/tree/2018/inference-engine
Intel CPU plug-in	(Intel® Math Kernel Library (Intel® MKL) only) ¹	(BLAS, Intel® MKL, jit (Intel MKL))	/opencv/dldt/tree/2018/inference-engine
Intel GPU (Intel® Processor Graphics) plug-in	✓	✓	/opencv/dldt/tree/2018/inference-engine
Heterogeneous plug-in	✓	✓	/opencv/dldt/tree/2018/inference-engine
Intel GNA plug-in	✓		
Intel® FPGA plug-in	✓		
Intel® Neural Compute Stick (1 & 2) VPU plug-in	✓		
Intel® Vision Accelerator based on Movidius plug-in	✓		
30+ Pretrained Models - incl. Model Zoo (IR models that run in IE + open sources models)	✓	✓	https://github.com/opencv/open_model_zoo
Computer Vision Algorithms	✓	✓	
Samples (APIs)	✓	✓	/opencv/dldt/tree/2018/inference-engine
Demos	✓	✓	https://github.com/opencv/open_model_zoo
Traditional Computer Vision			
OpenCV*	✓	✓	https://github.com/opencv/opencv
OpenVX (with samples)	✓		
Intel® Media SDK	✓	✓ ²	https://github.com/Intel-Media-SDK/MediaSDK
OpenCL™ Drivers & Runtimes	✓	✓ ²	https://github.com/intel/compute-runtime
FPGA Runtime Environment, Deep Learning Core and Visual Computing Group (Linux* only)	✓		

¹Intel MKL is not open source but

²Refer to readme file for validated versions



Application development with Intel® Distribution of OpenVINO™ Toolkit



Speed Deployment with Intel Optimized Pre-trained Models

OpenVINO™ toolkit includes optimized pre-trained models to expedite development and improve deep learning inference on Intel® processors. Use these models for development & production deployment without the need to search for or to train your own models.

Pre-Trained Models

- Age & Gender
- Face Detection – standard & enhanced
- Head Position
- Human Detection – eye-level & high-angle detection
- Detect People, Vehicles & Bikes
- License Plate Detection: small & front facing
- Vehicle Metadata
- Human Pose Estimation
- Text Detection
- Vehicle Detection
- Retail Environment
- Pedestrian Detection
- Pedestrian & Vehicle Detection
- Person Attributes Recognition Crossroad
- Emotion Recognition
- Identify Someone from Different Videos – standard & enhanced
- Facial Landmarks
- Identify Roadside objects
- Advanced Roadside Identification
- Person Detection & Action Recognition
- Person Re-identification – ultra small/ultra fast
- Face Re-identification
- Landmarks Regression
- Smart Classroom Use Cases
- Single image Super Resolution (3 models)

Save Time with Deep Learning Samples & Computer Vision Algorithms

Samples

Use Model Optimizer & Inference Engine for public models & Intel pretrained models.

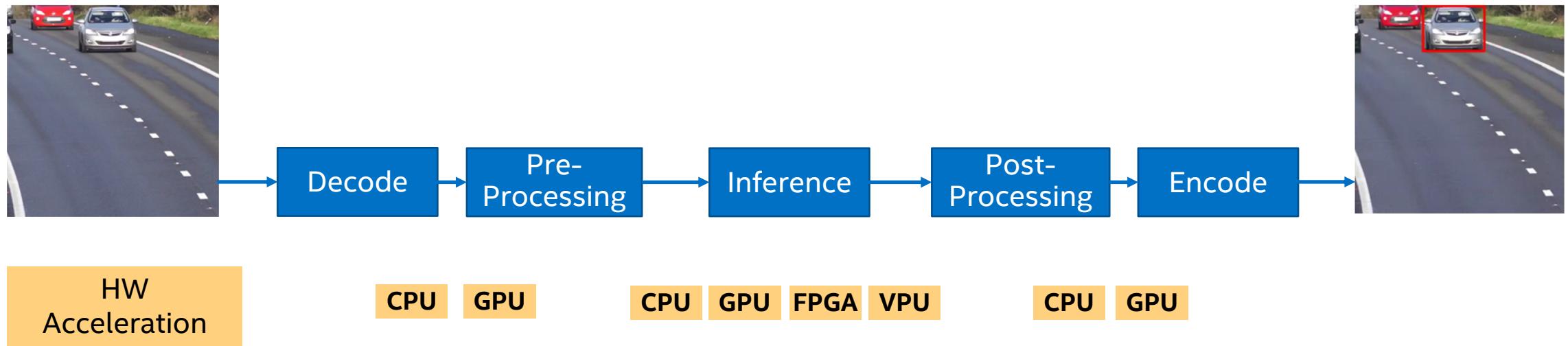
- Object Detection
- Standard & Pipelined Image Classification
- Security Barrier
- Object Detection for Single Shot Multibox Detector (SSD) using Asynch API
- Object Detection SSD
- Neural Style Transfer
- Hello Infer Classification
- Interactive Face Detection
- Image Segmentation
- Validation Application
- Multi-channel Face Detection

Computer Vision Algorithms

Start quickly with highly-optimized, ready-to-deploy, custom-built algorithms using Intel pretrained models.

- Face Detector
- Age & Gender Recognizer
- Camera Tampering Detector
- Emotions Recognizer
- Person Re-identification
- Crossroad Object Detector
- License Plate Recognition
- Vehicle Attributes Classification
- Pedestrian Attributes Classification

Full Pipeline Optimization



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

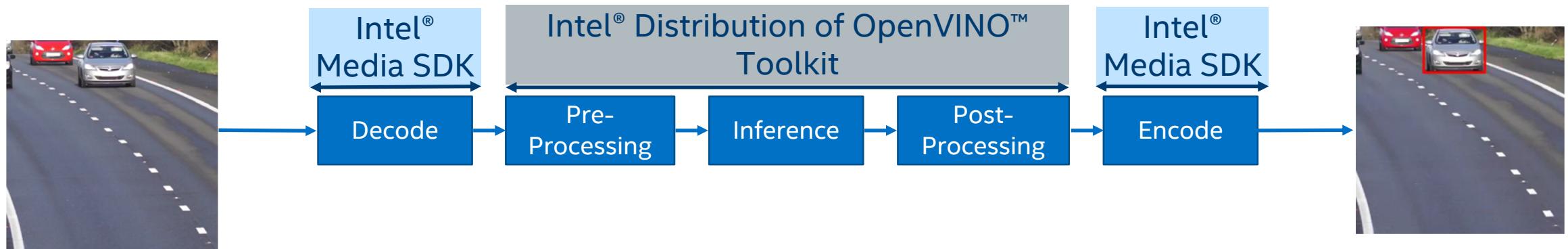
Embedded Linux*



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

Accelerate Streaming Performance, Integrate Video Analytics Computer Vision Needs Intel® Media SDK

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

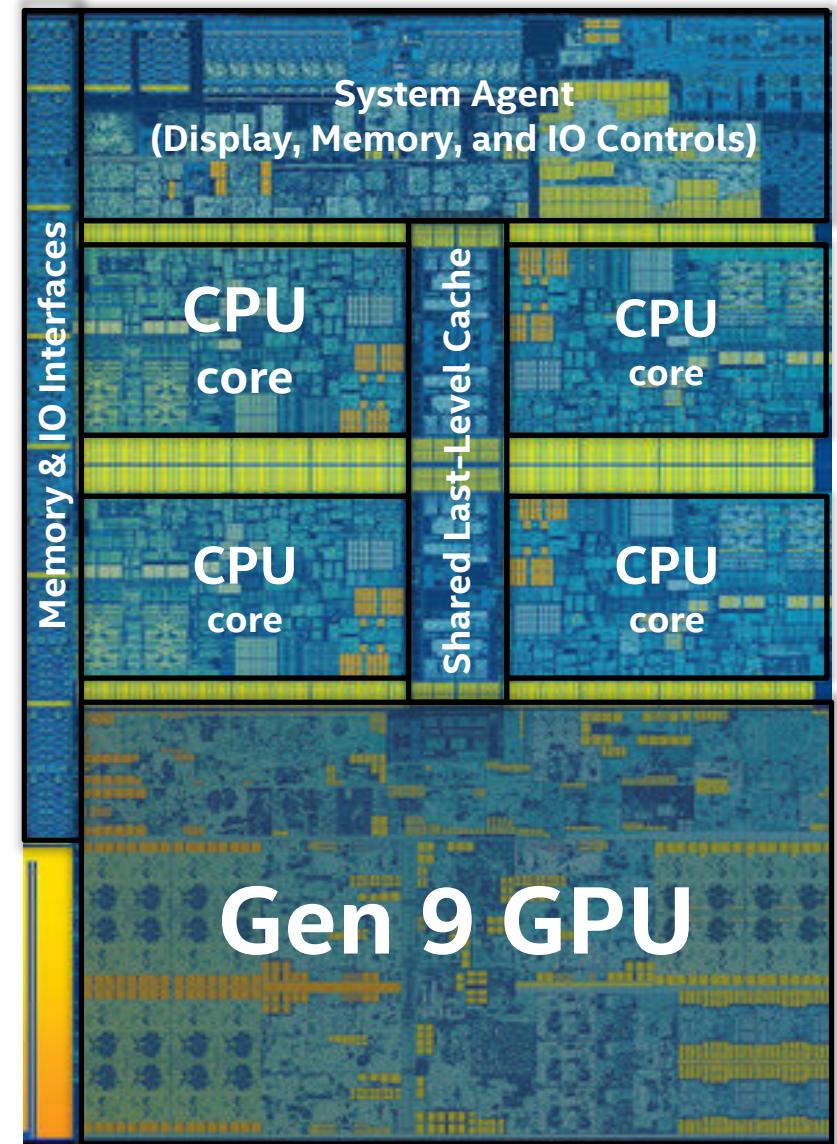


Intel Integrated Graphics

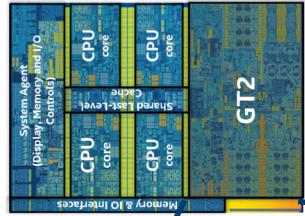
Gen is the internal name for Intel's on-die GPU solution. It's a hardware ingredient with various configurations.

- 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



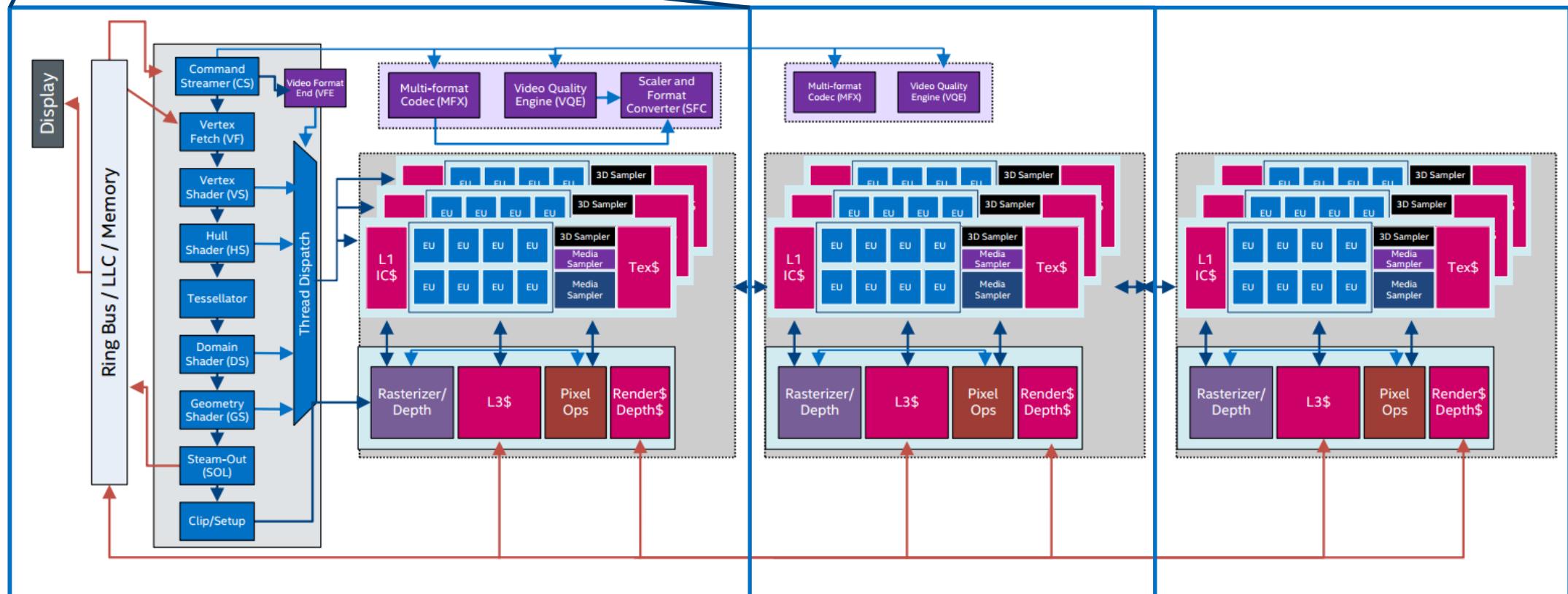
Intel GPU Configurations



GT2
Intel® HD Graphics
24 EUs, 1 MFX

GT3
Intel® Iris® Graphics
48 EUs, 2 MFX

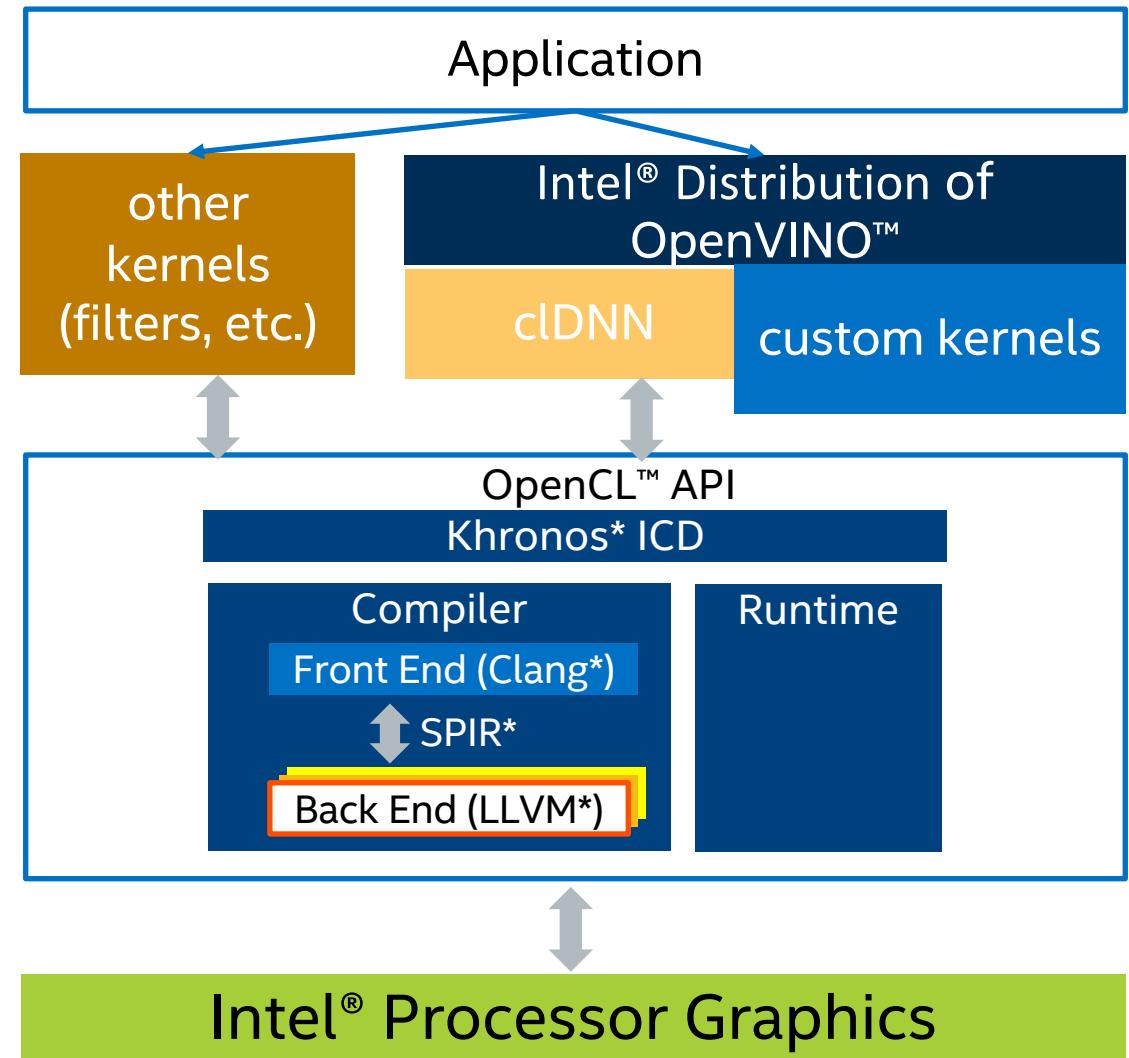
GT4
Intel® Iris® Pro Graphics
72 EUs, 2 MFX



OpenCL™

OpenCL™:

- Required to run with a GPU target (clDNN) using Intel® Processor Graphics
- Custom kernels
- Other kernels can be used for other non-inference pipeline stages, such as color conversions



Putting It All Together

- A major challenge is to get all these tool and libraries to work together in the best possible way to minimize development time and optimize system power/performance.
- A good way to abstract that workload is using an end-to-end pipeline

Computer Vision



Deep Learning



Media



SDKs



Optimized CV
Capabilities

Intel® Distribution of OpenVINO™ Toolkit



Intel® Deep Learning
Deployment Toolkit



Intel® Media SDK

Tools

Compiler, Analyzers, Debuggers



OpenCL™ SDK

Libraries

IPP



TBB



Intel®
MKL-DNN



Intel® MKL
DAAL



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

Hardware Acceleration

Optimization

Application

Edge deployment

2. Basic End-to-End Object Detection Example

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

6. Optimization Tools and Techniques

7. Advanced Video Analytics

8. UP2 AI Vision Development kit as Edge

