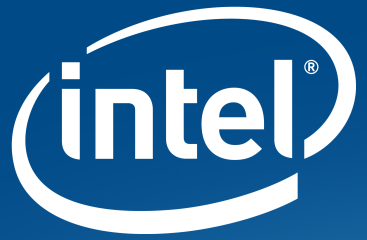

ACCELERATE DEEP LEARNING INFERENCE USING INTEL TECHNOLOGIES

INTRODUCTION: SMART VIDEO

October 2019

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

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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.

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*Other names and brands may be claimed as the property of others.

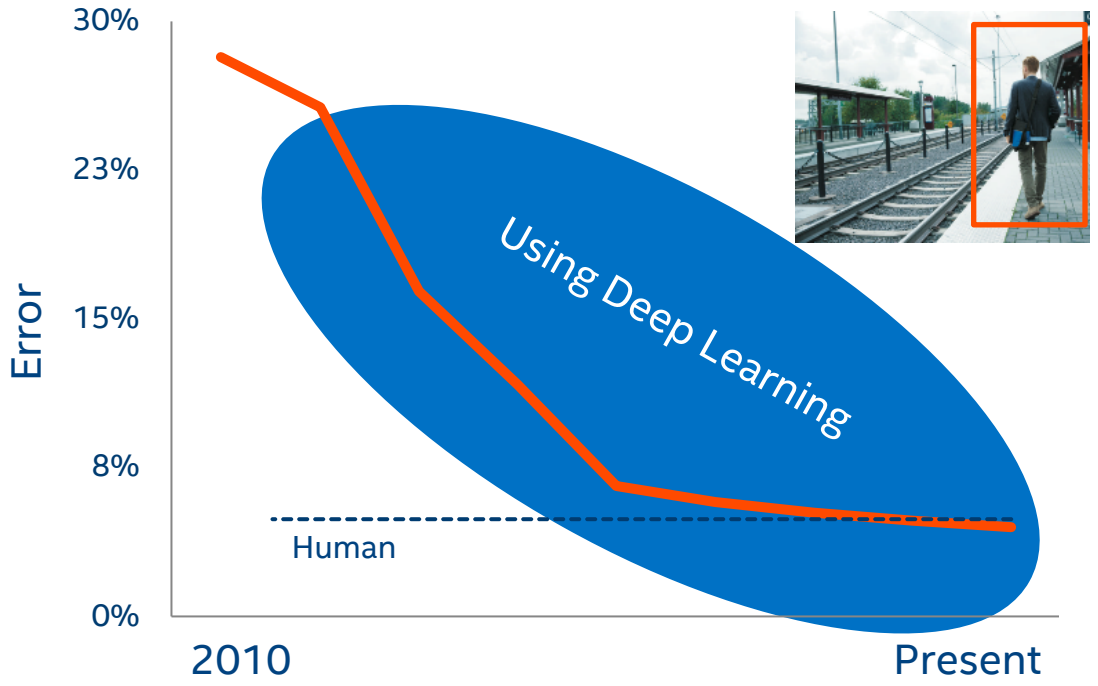
VIDEO: THE "EYE OF IOT"

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

Deep Learning Usage Is Increasing

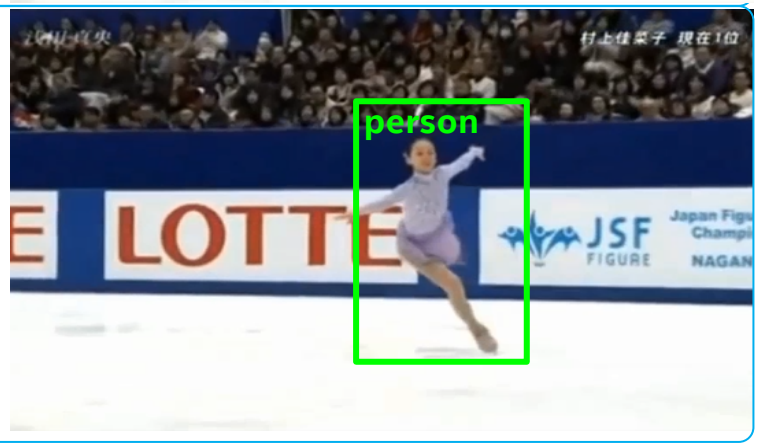
Deep learning revenue is estimated to grow from $655M in 2016 to $35B by 2025[1].

Image Recognition



Traditional Computer Vision
Object Detection

Deep Learning Computer Vision
Person Recognition



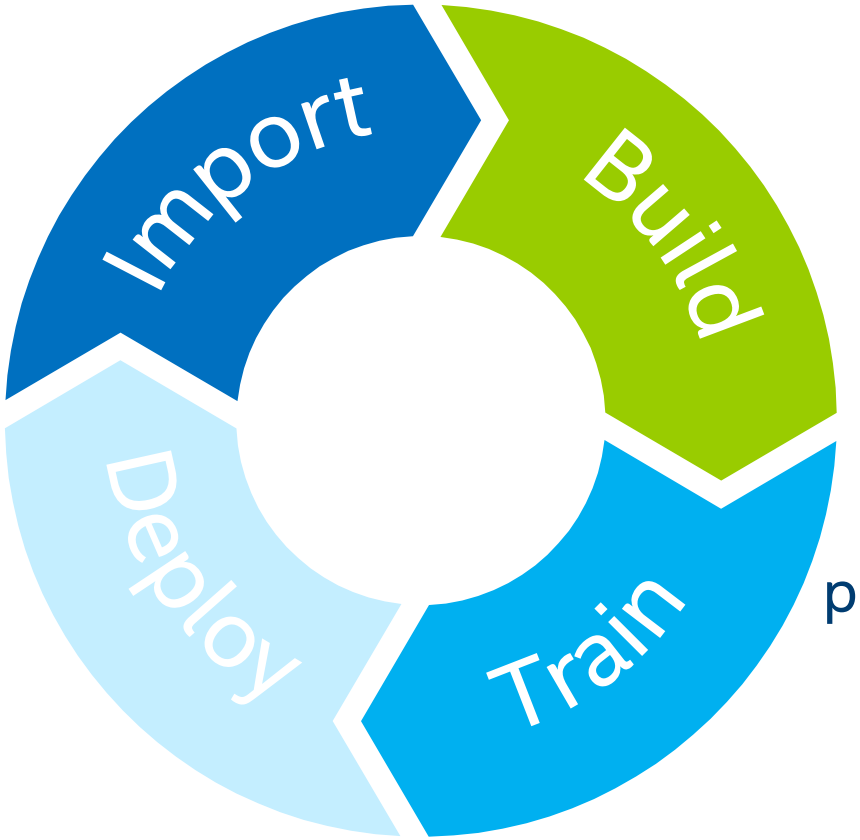
Market Opportunities + Advanced Technologies Have Accelerated Deep Learning Adoption

[1]Tractica* 2Q 2017

Deep Learning Development Cycle

Data aquisition and organization

Create models



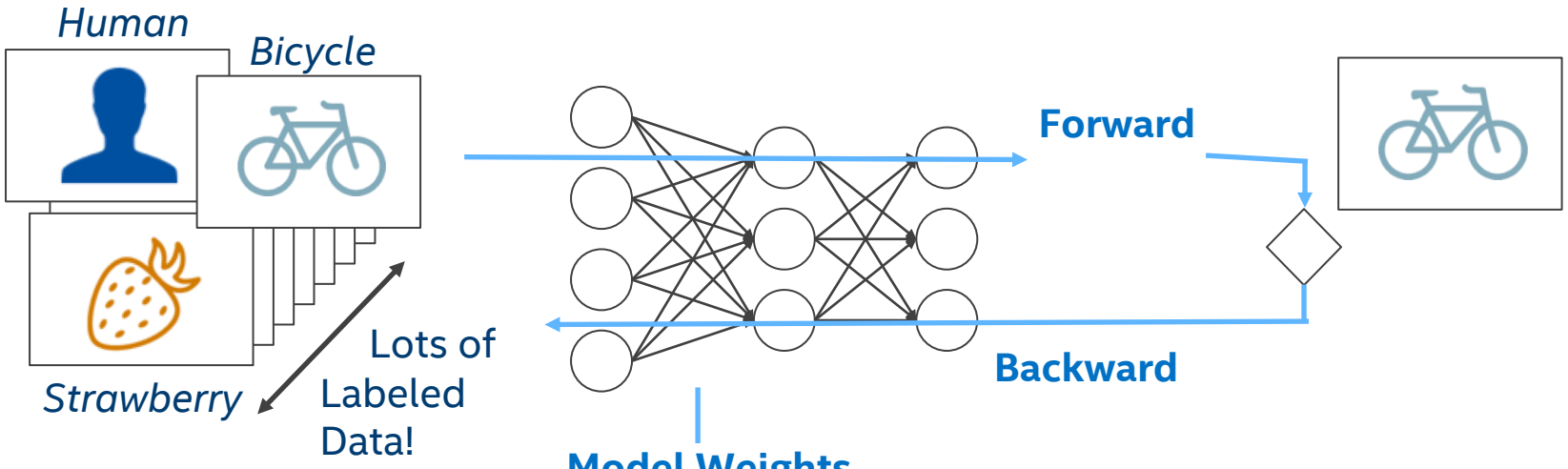
Integrate trained models with application code

Adjust models to meet performance and accuracy objectives

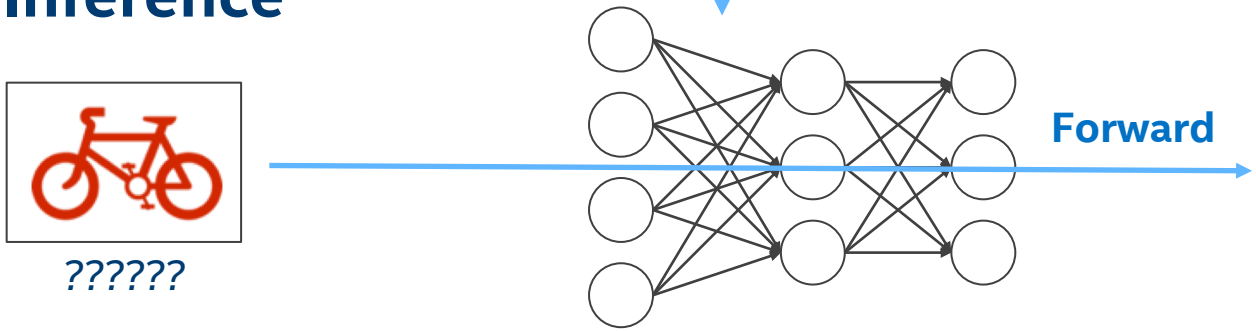
Intel® Distribution OpenVINO™ Toolkit Provides Deployment from Intel® Edge to Cloud

Deep Learning: Training vs. Inference

Training

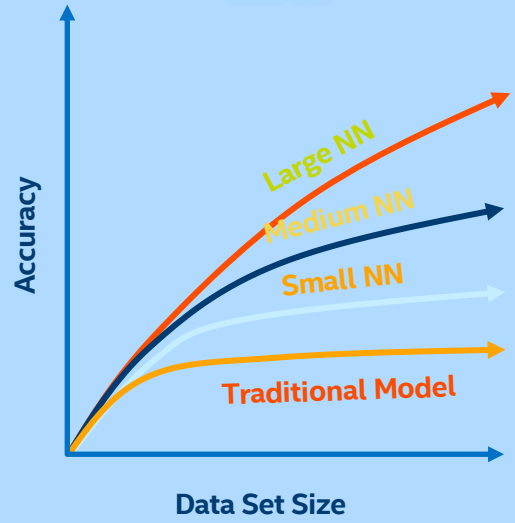


Inference



Did You Know?

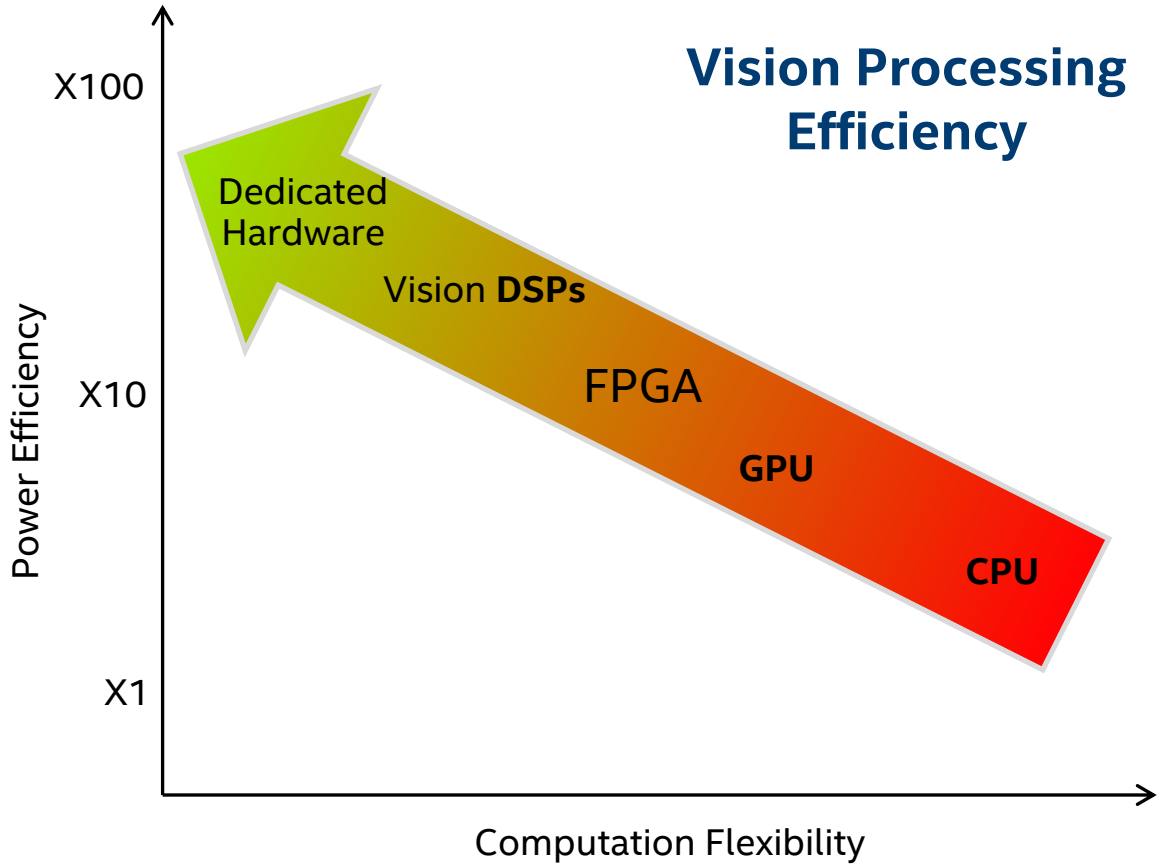
Training requires a very large data set and deep neural network (many layers) to achieve the highest accuracy in most cases



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

Apache Spark MLlib BigDL
TensorFlow
mxnet
theano
neon
Caffe
torch
ONNX

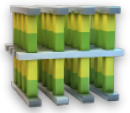
LIBRARIES

Intel® Data Analytics Acceleration Library
Intel® Distribution for python
Intel® Math Kernel Library
Intel® Nervana™ Graph
Movidius Stack
saffron TECHNOLOGY an intel company

UNLEASH FULL POTENTIAL

HARDWARE

Compute: Intel Atom, Quark, Core i7, Xeon, Arria 10, Movidius inside



Memory & Storage

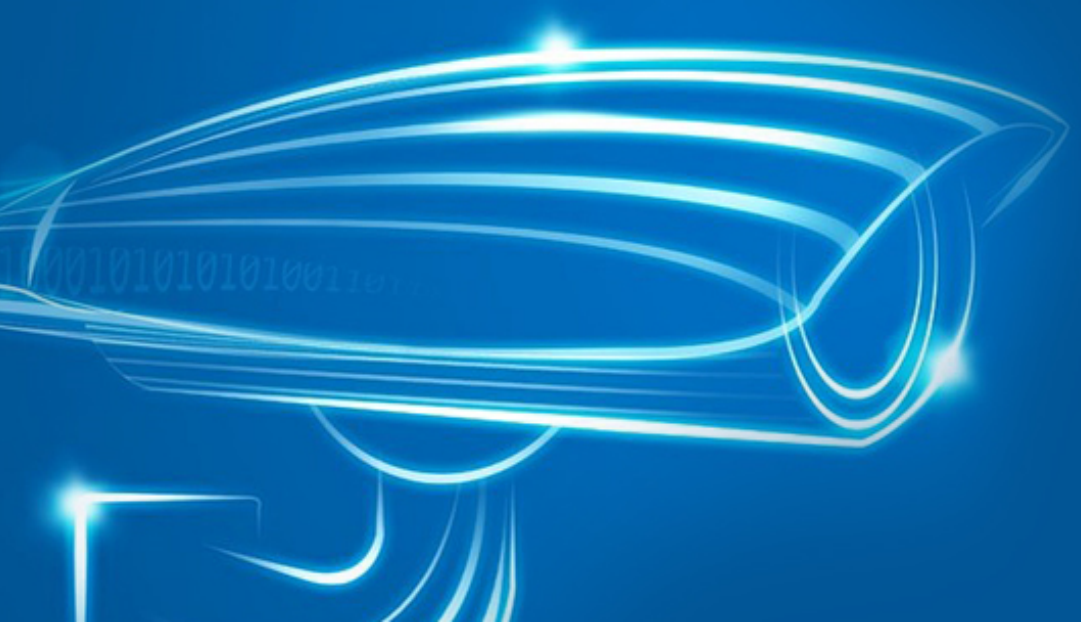
Networking

intel RealSense Technology
intel Movidius

Visual Intelligence

INTEL® DISTRIBUTION OF OPENVINO™ TOOLKIT

Take your computer vision solutions to a new level with deep learning inference intelligence.



What it is

A toolkit to accelerate development of **high performance computer vision** & **deep learning inference into vision/AI applications** used from edge to cloud. It enables deep learning on hardware accelerators and 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, text) & more.

HIGH PERFORMANCE, PERFORM AI AT THE EDGE

STREAMLINED & OPTIMIZED DEEP LEARNING INFERENCE

HETEROGENEOUS, CROSS-PLATFORM FLEXIBILITY

Free Download ▸ software.intel.com/openvino-toolkit

Open Source version ▸ 01.org/openvinotoolkit

What's Inside Intel® Distribution of OpenVINO™ toolkit

Deep Learning

Intel® Deep Learning Deployment Toolkit

Model Optimizer
Convert & Optimize

IR

Inference Engine
Optimized Inference

IR = Intermediate Representation file

Open Model Zoo

- 40+ Pretrained Models
- Samples
- Model Downloader

Deep Learning Workbench

- Calibration Tool
- Model Analyzer
- Benchmark App
- Accuracy Checker
- Aux. Capabilities

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), macOS* 10.13 & 10.14 (64 bit)

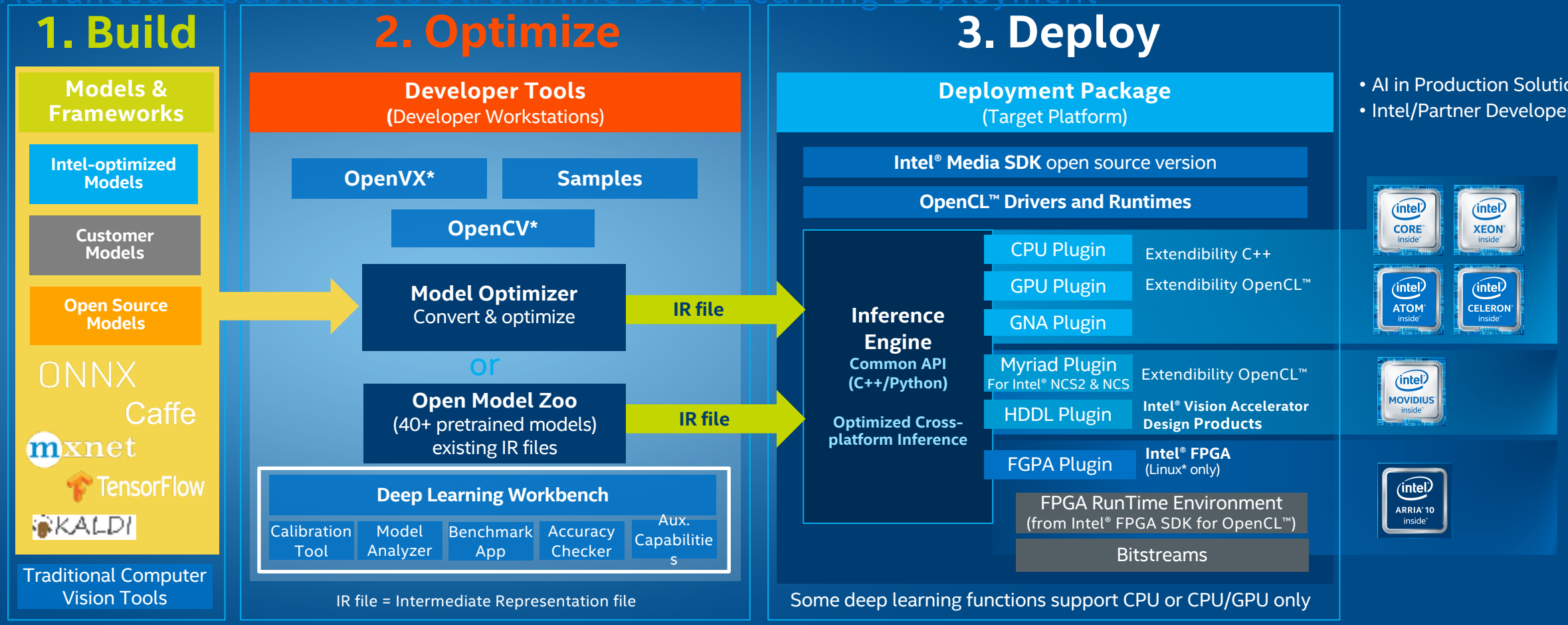
Intel® Architecture-Based Platforms Support

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

An open source version is available at 01.org/openvinotoolkit (deep learning functions support for Intel CPU/GPU/NCS/GNA).

Using the Intel® Distribution of OpenVINO™ toolkit

Advanced Capabilities to Streamline Deep Learning Deployment



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

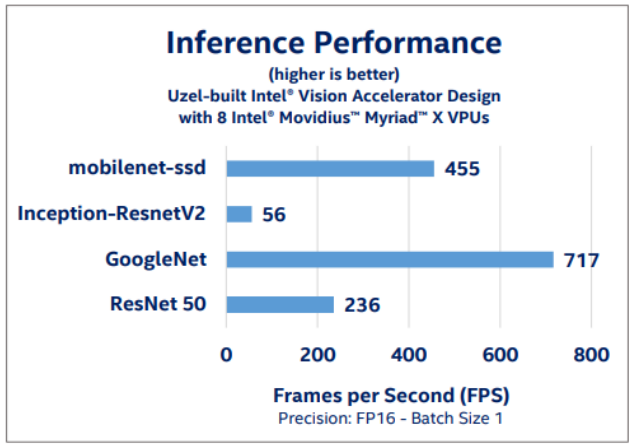
Quick Guide: What's Inside the Intel Distribution vs Open Source version

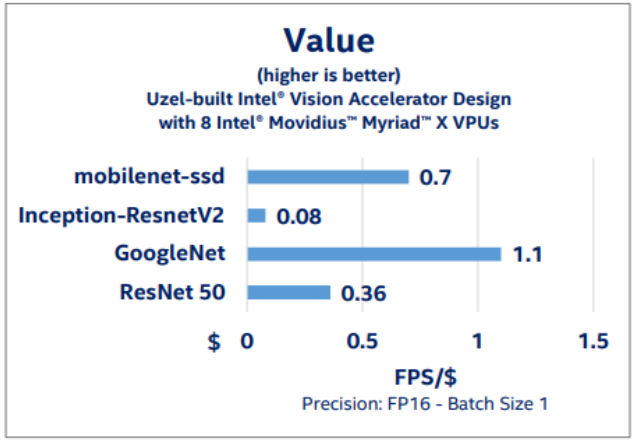
Tool/Component	Intel® Distribution of OpenVINO™ toolkit	OpenVINO™ toolkit (open source)	Open Source Directory
Installer (including necessary drivers)	✓		
Intel® Deep Learning Deployment toolkit			
Model Optimizer	✓	✓	/opencv/dldt/tree/2018/model-optimizer
Inference Engine	✓	✓	/opencv/dldt/tree/2018/inference-engine
Intel CPU plug-in	✓ Intel® Math Kernel Library (Intel® MKL) only[1]	✓ BLAS, Intel® MKL[1], jit (Intel MKL)	/opencv/dldt/tree/2019/inference-engine
Intel GPU (Intel® Processor Graphics) plug-in	✓	✓	/opencv/dldt/tree/2019/inference-engine
Heterogeneous plug-in	✓	✓	/opencv/dldt/tree/2019/inference-engine
Intel GNA plug-in	✓	✓	/opencv/dldt/tree/2019/inference-engine
Intel® FPGA plug-in	✓		
Intel® Neural Compute Stick (1 & 2) VPU plug-in	✓	✓	/opencv/dldt/tree/2019/inference-engine
Intel® Vision Accelerator based on Movidius plug-in	✓		
40+ Pretrained Models - incl. Model Zoo (IR models that run in IE + open sources models)	✓	✓	https://github.com/opencv/open_model_zoo
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 Acceleration & Bitstreams (Linux* only)	✓		

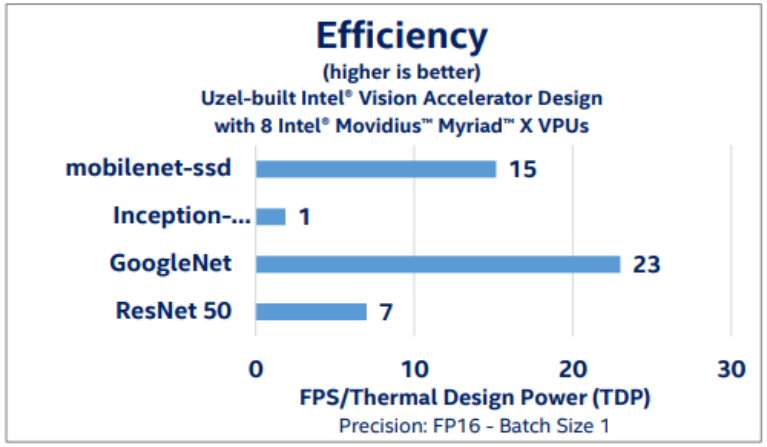
New Benchmarks for HDDL Accelerators – June 2019

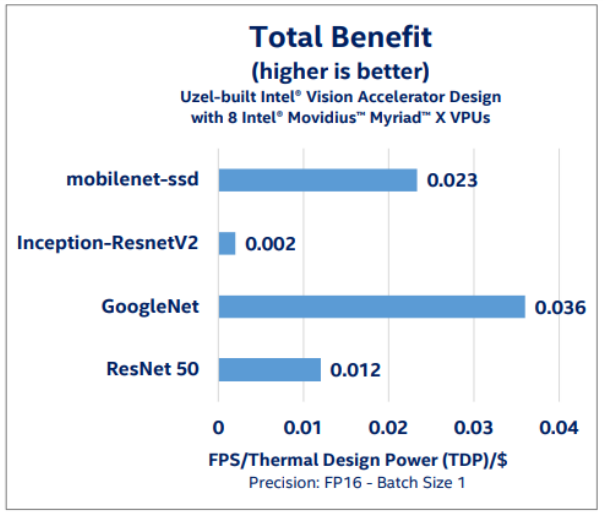
Increase Deep Learning Model Performance with **Intel® Movidius™ VPU** & Intel® Distribution of OpenVINO™ toolkit

Location: Intel® Distribution of OpenVINO™ toolkit product site > Hardware > **Performance Benchmarks**









CONFIGURATIONS: Testing by Intel as of March 29, 2019 **See slide 59 for configuration details.**

Speed Deployment with Pretrained Models & Samples

Expedite development, accelerate deep learning inference performance, speed production deployment

Pretrained Models in Intel® Distribution of OpenVINO™ toolkit

- 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
- Action recognition–encoder & decoder
- Text Detection & Recognition
- Vehicle Detection
- Retail Environment
- Pedestrian Detection
- Pedestrian & Vehicle Detection
- Person Attributes Recognition Crossroad
- Emotion Recognition
- Identify Someone from Different Videos–standard & enhanced
- Facial Landmarks
- Gaze estimation
- 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
- Super Resolution
- Instance segmentation
- Image retrieval
- & more…

Binary Models

- Face Detection Binary
- Pedestrian Detection Binary
- Vehicle Detection Binary
- ResNet50 Binary

Save Time with Deep Learning Samples

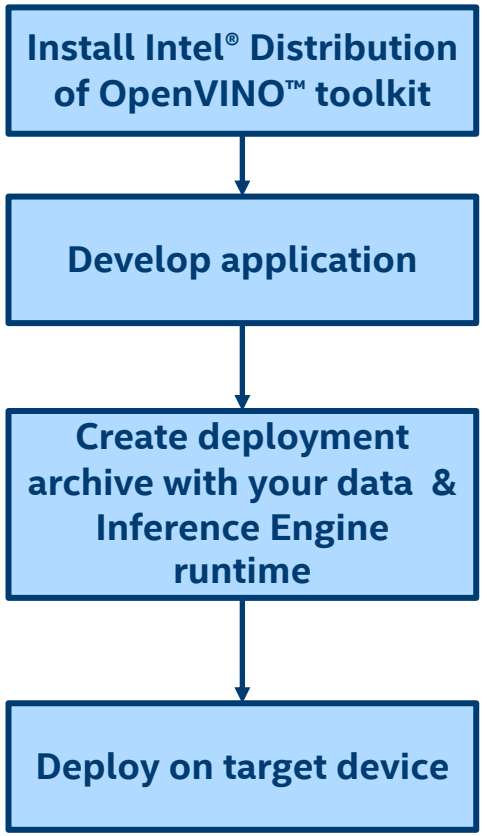
Use Model Optimizer & Inference Engine for Public Models & Intel Pretrained Models

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

Command Line Deployment Manager

- Generate an optimal, minimized runtime package for selected target device.
- Deploy Inference Engine with pre-compiled application-specific data such as models, config, and a subset of required hardware plugins.
- Achieve deployment footprint to be several times smaller than the development footprint.

For more details, see Introduction to CLI Deployment Manager

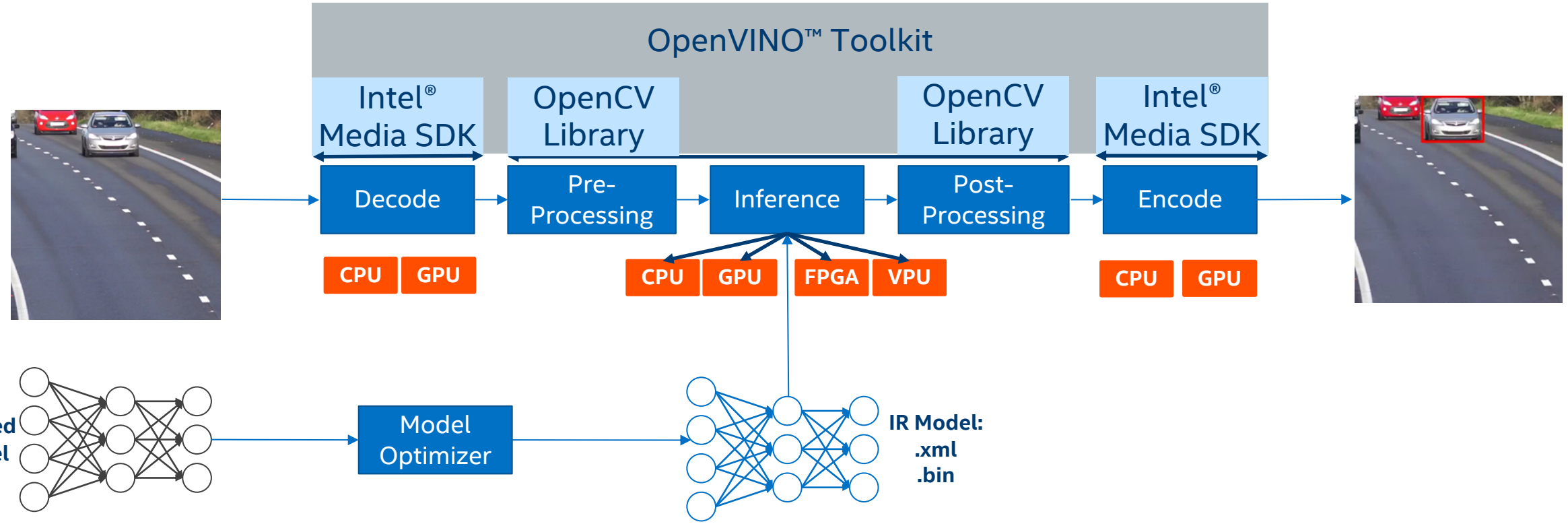


Target	Size, MB
CPU only	65
GPU only	26
Myriad only	22
HDDL only	27
GNA only	15

Measurements for deployment archives based on 2019 R3

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.



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*

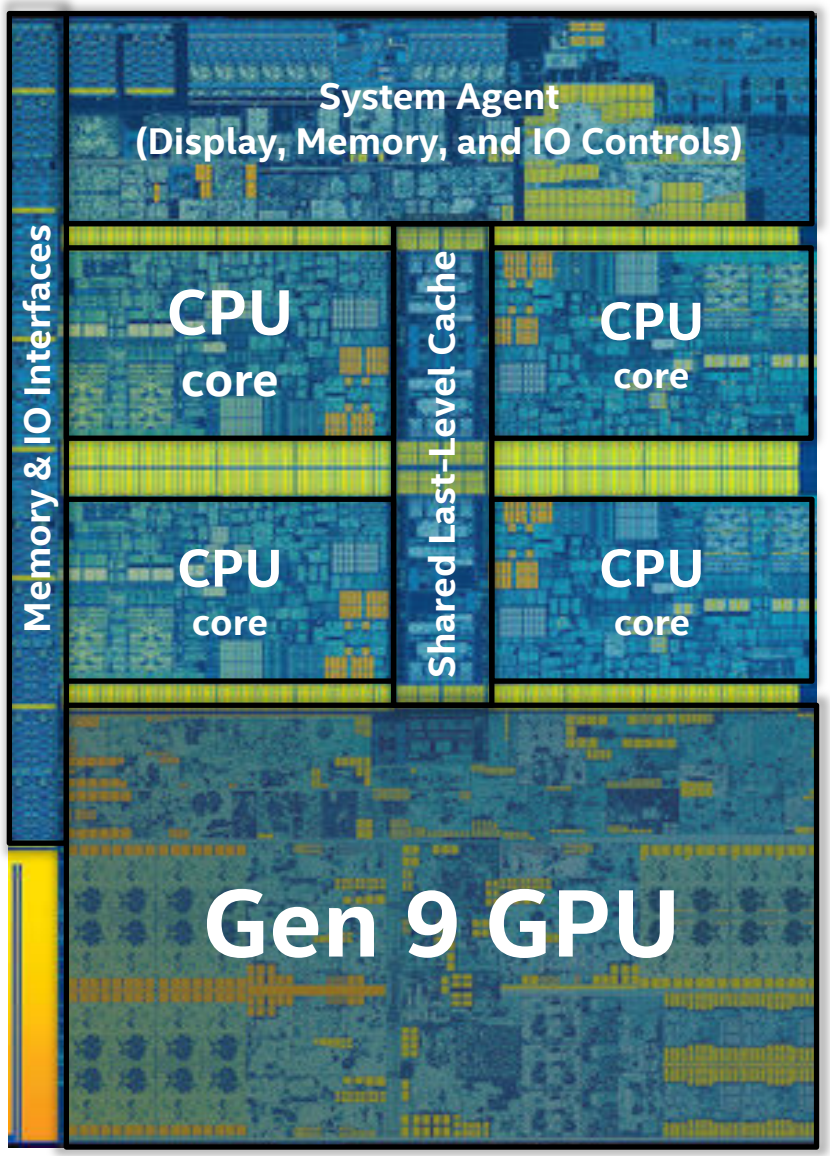
yocto PROJECT

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

Intel Integrated Graphics

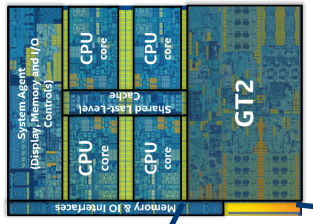
Gen is the internal name for Intel's on-die GPU solution. It's a hardware ingredient with various configurations.

- 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

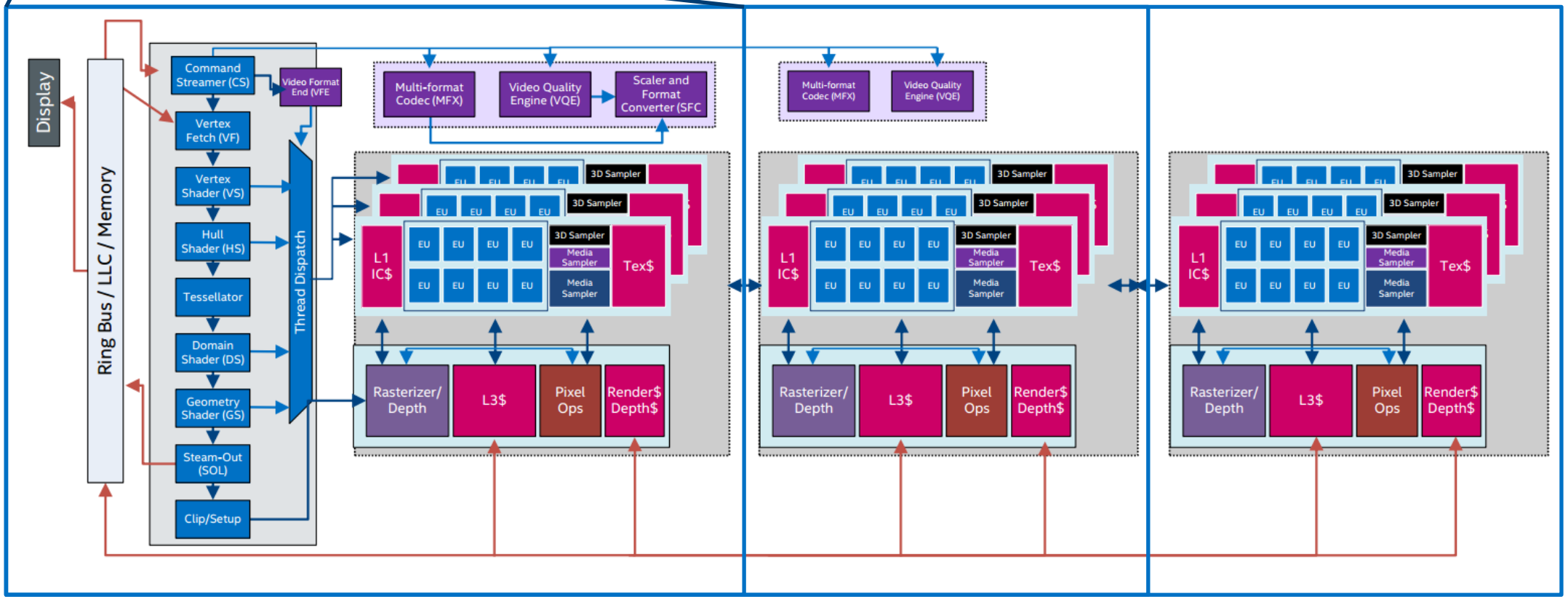
Intel GPU Configurations

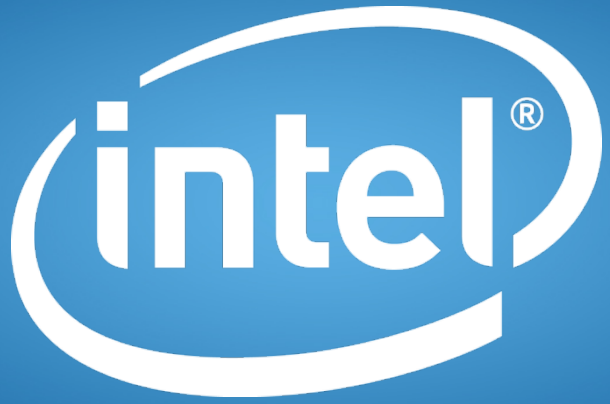


GT2
Intel® HD Graphics
24 EUs, 1 MFX

GT3
Intel® Iris® Graphics
48 EUs, 2 MFX

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




intel®