



JETSON XAVIER NX DEVELOPER KIT - NEXT LEAP IN EDGE COMPUTING

May 20, 2020





AGENDA

Jetson Xavier NX Developer Kit

Hardware specs, performance, and I/O

JetPack 4.4 Developer Preview

Latest software, cloud-native, and inferencing benchmarks

Getting Started

Resources, open-source projects, tips & tricks

Q & A

Live question and answer session

JETSON DEVELOPER COMMUNITY

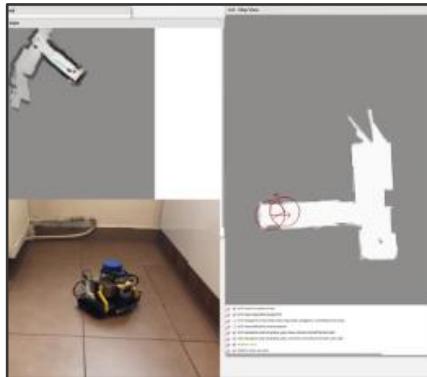
500K+ Engineers, Hobbyists, Makers, Students



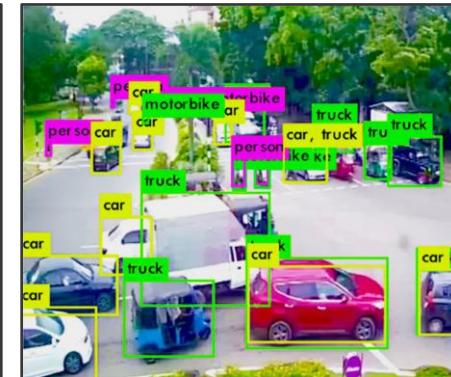
Weed Removal Robot



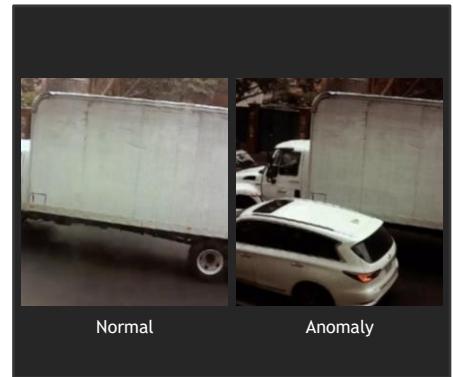
Sim-to-Real Navigation



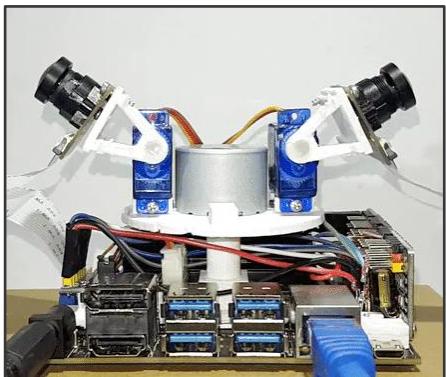
Autonomous Toy Tank



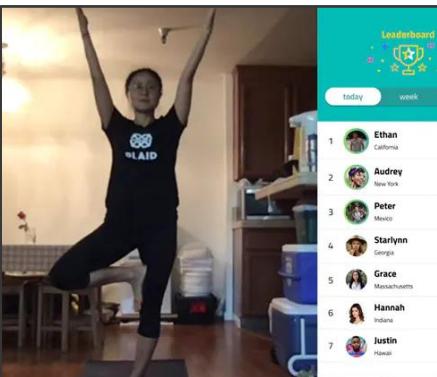
Adaptive Traffic Control



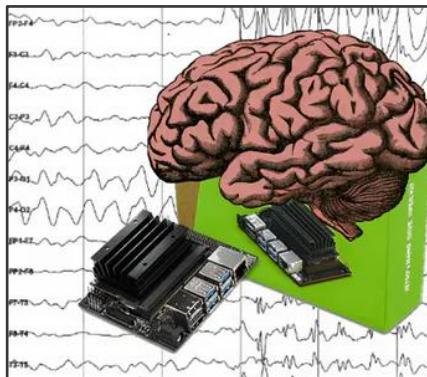
Anomaly Detection



Video Analytics



Streaming Yoga Platform



Brain Wave Decoder



Water Testing



Reading Eye for the Blind

NVIDIA JETSON POWERED PRODUCTION AI DEVICES

Adoption by 3000+ Customers / Companies



VERIZON
Traffic



OXFORD NANOPORE
Healthcare



JOHN DEERE
Agriculture



CISCO
Collaboration



DRL
Autonomous Drone



POSTMATES
Delivery



RIVER SYSTEMS
Warehouse



FOXCONN
Inspection

JETSON XAVIER NX DEVELOPER KIT

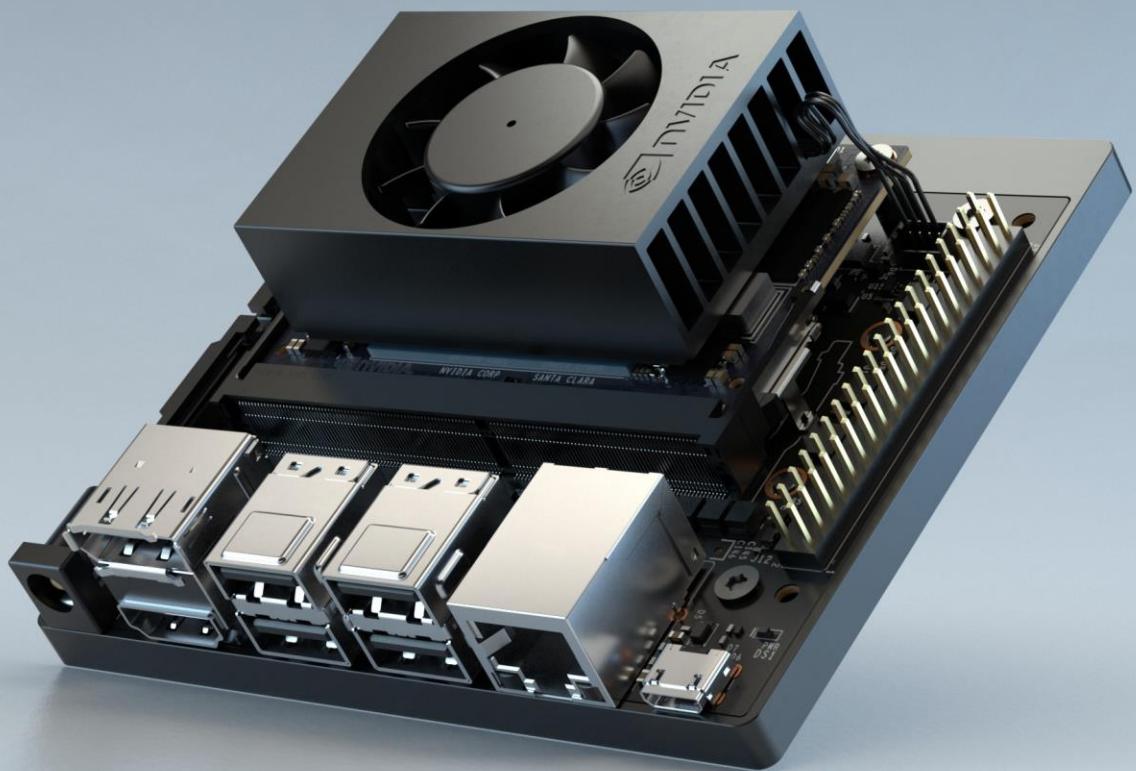
Xavier Performance. Nano Size.

Up to 21 TOPS of AI Performance

Cloud-Native Ready

10-15W

\$399



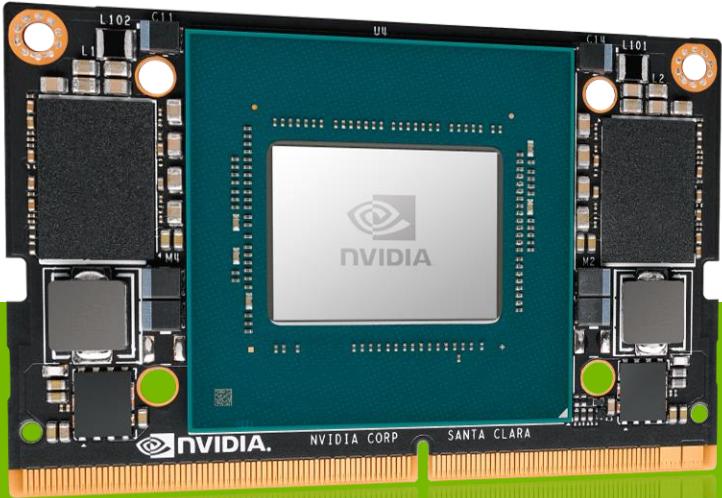
JETSON XAVIER NX DEVKIT SPECS



PROCESSOR		INTERFACES	
CPU	6-core ARMv8.2 @ 1.4GHz (1.9GHz dual-core)	USB	(4x) USB 3.1 A (Host) USB 2.0 Micro B (Device)
GPU	384-core Volta @ 1100Mhz with 48 Tensor Cores	Camera	(2x) MIPI CSI-2 x2 (15-position Flex Connector)
Memory	8GB 128-bit LPDDR4 @ 1600MHz 51.2GB/s	Display	HDMI DisplayPort
DL Accelerator	Dual NVIDIA Deep Learning Accelerators (NVDLA)	Networking	Gigabit Ethernet (RJ45, PoE)
Vision Accelerator	7-way VLIW Vision Processor	Wireless	M.2 Key-E (2x2 802.11 WLAN + BT 5.0 provided)
Video Encoder	(2x) 4Kp30 (6x) 1080p60 (12x) 1080p30	Storage	MicroSD card M.2 Key-M 2280 NVMe (PCIe x4)
Video Decoder	(2x) 4Kp60 (4x) 4Kp30 (12x) 1080p60 (32x) 1080p30	40-Pin Header	(2x) I2C, (2x) SPI, UART, I2S, Audio Clk, GPIOs, PWMs
		Power	9-20V (19.5V supply provided) 10/15W modes
		Size	90x103mm

Distributors Include:



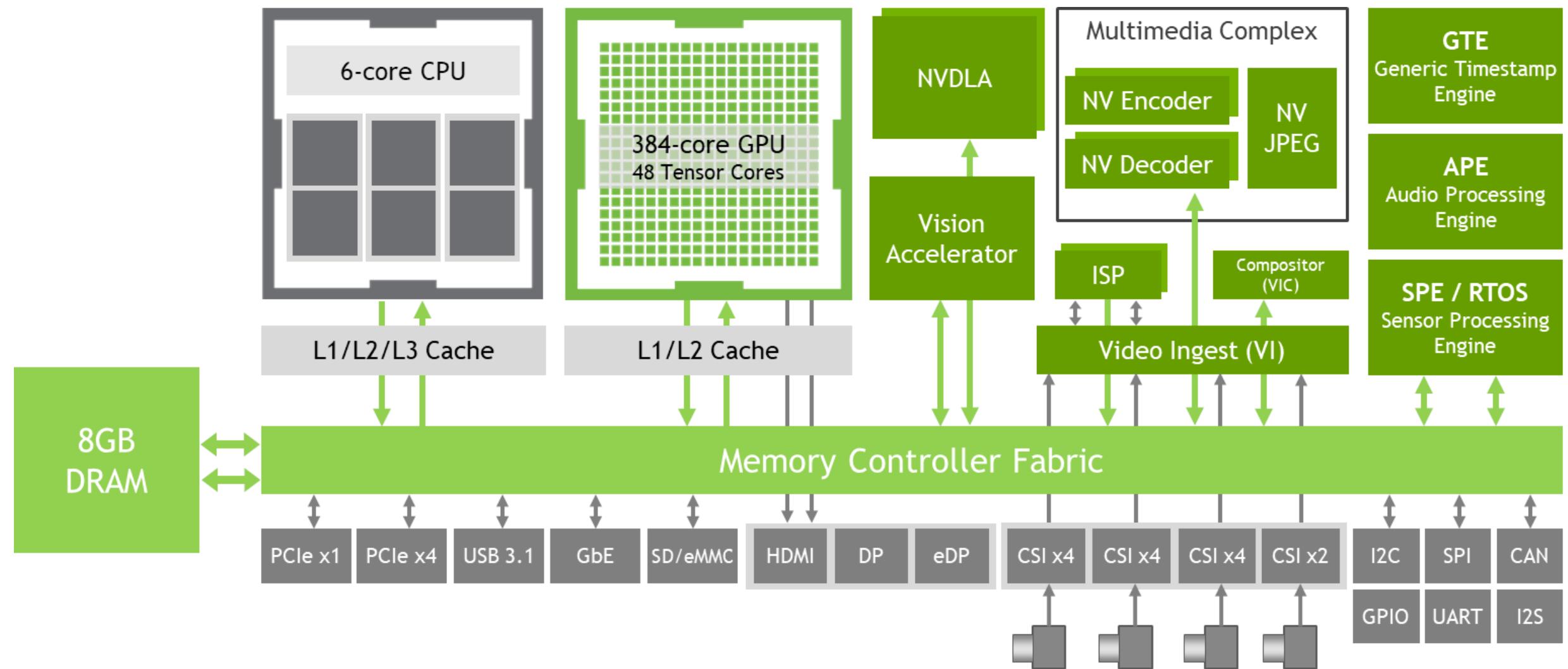


Jetson Xavier NX

Production Module
Nano Form-Factor
Available Now
\$399 (1KU+ QTY)



NX BLOCK DIAGRAM

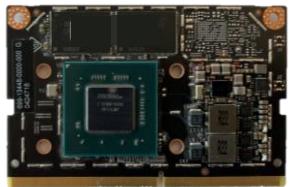


Refer to the [Jetson Xavier NX Module Data Sheet](#) for full specifications

JETSON AI COMPUTER LINEUP

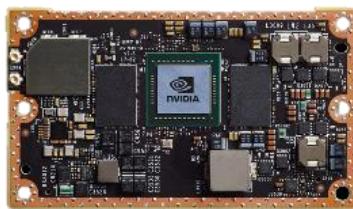
AI Platform for Entry, Mainstream, and Autonomous Edge Devices

JETSON NANO



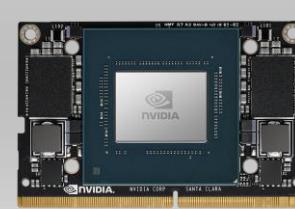
0.5 TFLOPS (FP16)
5-10W
45mm x 70mm
\$129

JETSON TX2 series
(TX2, TX2 4GB, TX2i*)



1.3 TFLOPS (FP16)
7.5-15W
50mm x 87mm
Starting at \$249

JETSON XAVIER NX



6 TFLOPS (FP16) | 21 TOPS (INT8)
10-15W
45mm x 70mm
\$399

JETSON AGX XAVIER series
(AGX Xavier, Xavier ind.)

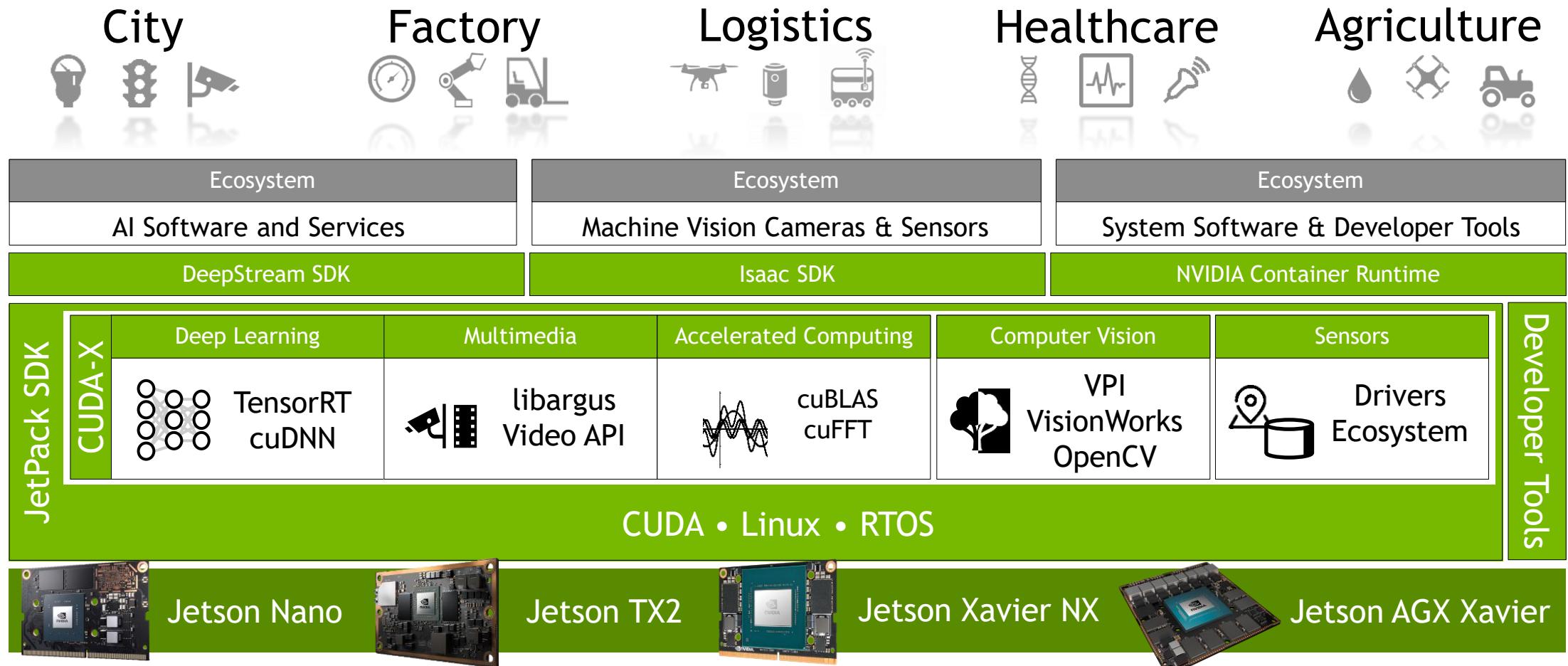


20-32 TOPS (INT8)
5.5-11 TFLOPS (FP16)
10-30W
100mm x 87mm
Starting at \$899

One Software Architecture

JETSON SOFTWARE

for Edge AI Devices



JETPACK 4.4 DEVELOPER PREVIEW



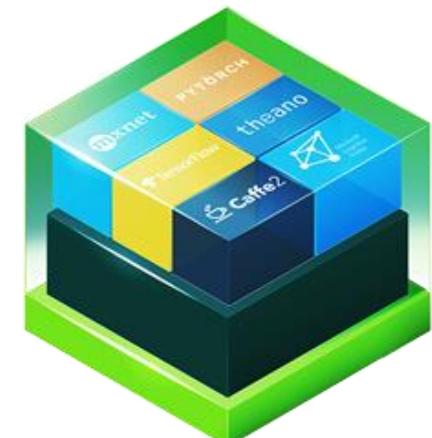
Available Now For Jetson
developer.nvidia.com/jetpack

L4T BSP	32.4.2
Linux Kernel	4.9.140
Container Runtime	1.0.1
Vulkan	1.2
OpenGL	4.6
OpenGL-ES	3.2.5
EGL	1.5
GLX	1.4
Wayland	1.16
L4T Multimedia API	32.4.2
Argus Camera API	0.97
GStreamer	1.14.5
Nsight Systems	2020.2
Nsight Graphics	2020.1
Jetson GPIO	2.0.8
Jetson OS	Ubuntu 18.04
Host OS	Ubuntu 16.04 / 18.04
SDK Manager	1.1.0

Package Versions

CUDA	10.2
cuDNN	8.0 DP
TensorRT	7.1 DP
VPI	0.2 DP
VisionWorks	1.6
OpenCV	4.1.1

Install TensorFlow, PyTorch, Caffe,
Caffe2, MXNet, ROS, containers,
and other GPU-accelerated libraries



OPEN FRAMEWORK SUPPORT

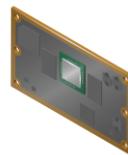
MACHINE LEARNING



ROBOTICS / IOT



JETSON



CLOUD NATIVE ON JETSON

Containers & Micro Services

Consistency Across Portfolio

- Update once and push broadly

Easier and Faster Deployment

- Eliminates complex, time-consuming builds and installs

Portable

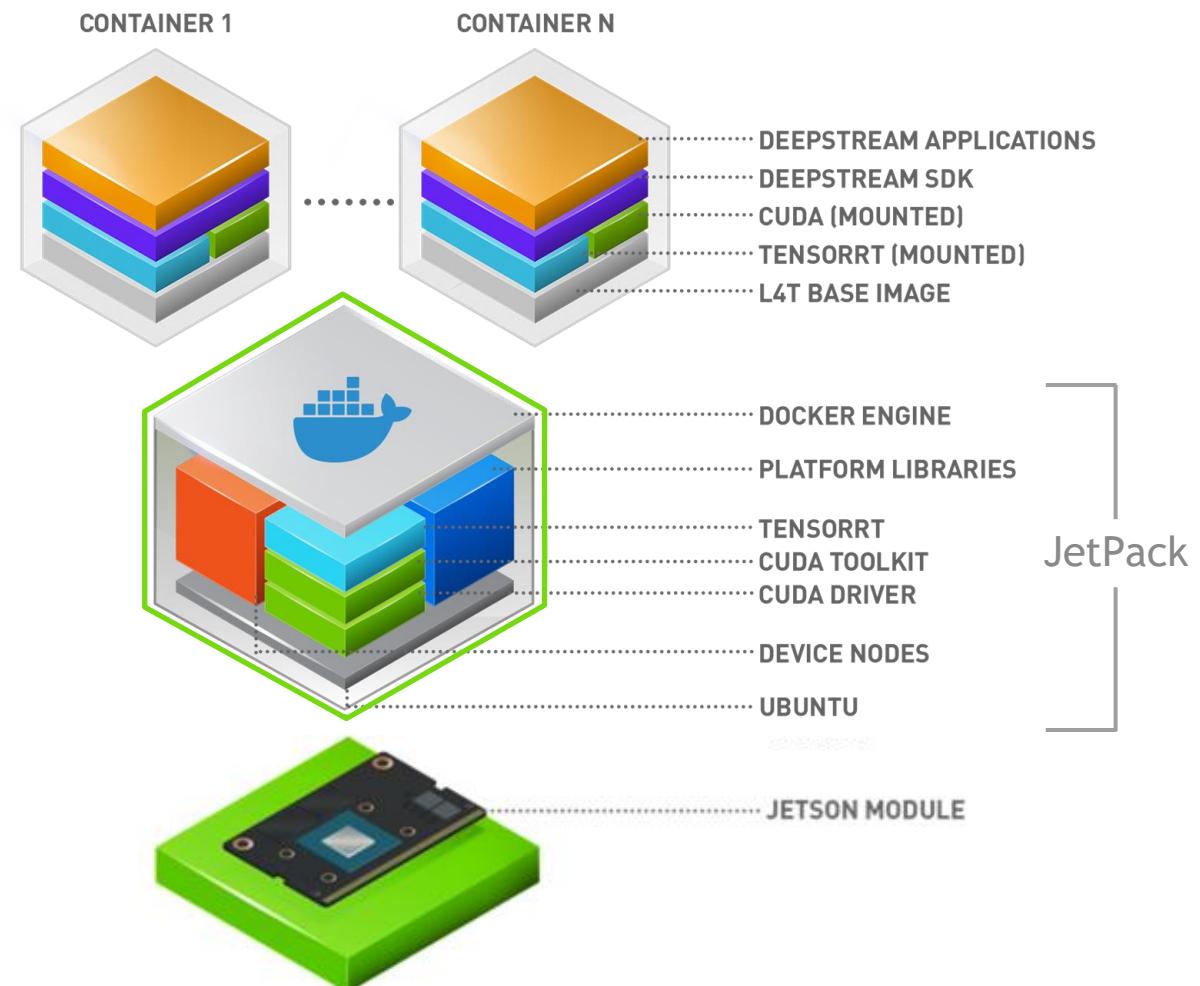
- Deploy across various environments, from test to production with minimal changes

Scalability

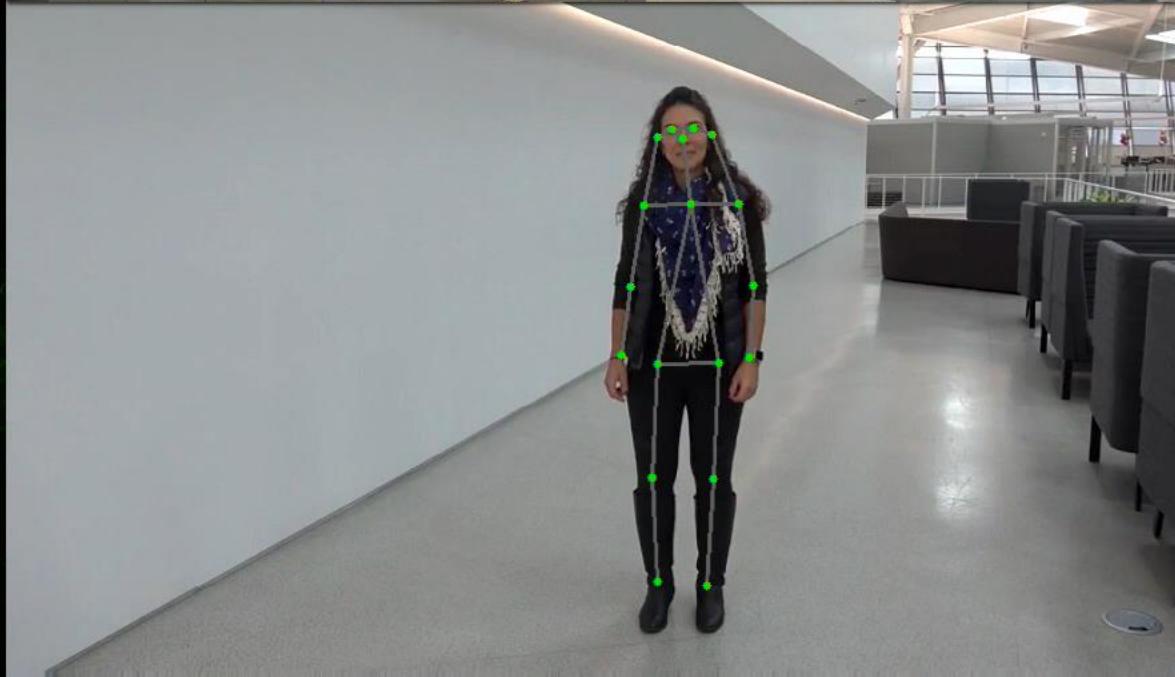
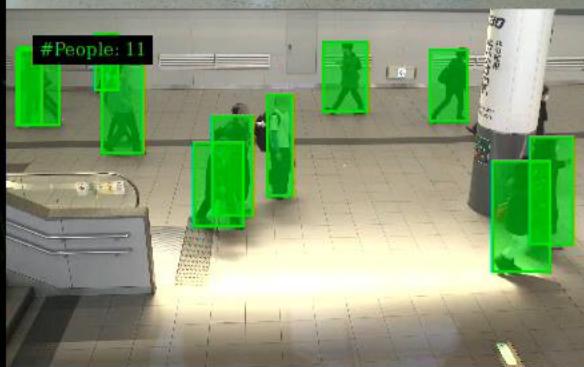
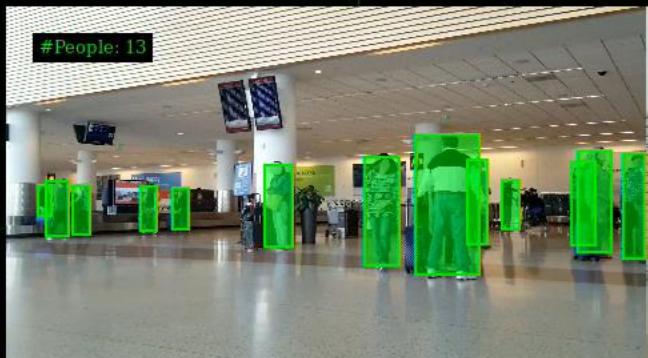
- Push the right container to the right platform

Agile and Easier Development

- Update specific modules not the whole system



Webinar 5/26 Jetson Xavier NX Brings
Cloud-Native Agility to Edge AI Devices



Topics: 1_BERT 2_GTC 3_Jetson_Xavier_NX 4_Cloud_Native 5_Football **Edit** **New** **Load** **Remove**

NVIDIA GTC is the GPU Technology Conference. This year it's being held online. The keynote is held in a live stream on May 14. Our CEO Jensen Huang will be presenting the keynote. In the keynote we have many exciting announcements to share about the future of AI and accelerated computing. There are also 650+ technical sessions that you can stream online. NVIDIA will be hosting more webinars following the keynote to discuss additional technical aspects of the announcements. Find out more by visiting nvidia.com/gtc

Passage:

**Partial:
Phrase:
Answer:**

Status
Mic Stream: mute
Mic Level: -80.1 dB

Keys
Push-to-Talk space
Select Topic #1 - 5
Cycle Topic ← →
Exit Escape



NGC CONTAINERS



Machine Learning for Jetson/L4T Container

The Machine learning container contains TensorFlow, PyTorch, JupyterLab, and other popular ML and data science frameworks such as scikit-learn, scipy, an...

[View Labels](#) [Pull Tag](#)

PyTorch for Jetson/L4T Container

PyTorch is a GPU accelerated tensor computational framework with a Python front end. Functionality can be easily extended with common Python libraries s...

[View Labels](#) [Pull Tag](#)

Tensorflow for Jetson/L4T Container

TensorFlow is an open-source software library for numerical computation using data flow graphs. Nodes in the graph represent mathematical operations, whil...

[View Labels](#) [Pull Tag](#)

DeepStream-l4t

Container

DeepStream SDK delivers a complete streaming analytics toolkit for real-time AI based video and image understanding and multi-sensor processing. DeepStream SD...

[View Labels](#) [Pull Tag](#)

nvidia-l4t-base

Container

NVIDIA L4T is a Linux based software distribution for the NVIDIA Jetson embedded computing platform.

[View Labels](#) [Pull Tag](#)

Pose Demo for Jetson/L4T Container

Pose Demo container showcasing pose detection running on Jetson.

[View Labels](#) [Pull Tag](#)

Voice Demo for Jetson/L4T Container

ASR + BERT QA interactive chatbot demo for Jetson

[View Labels](#) [Pull Tag](#)

DeepStream People Detection Demo ...

Container
DeepStream People Detection Demo container showcasing people detection running on Jetson.

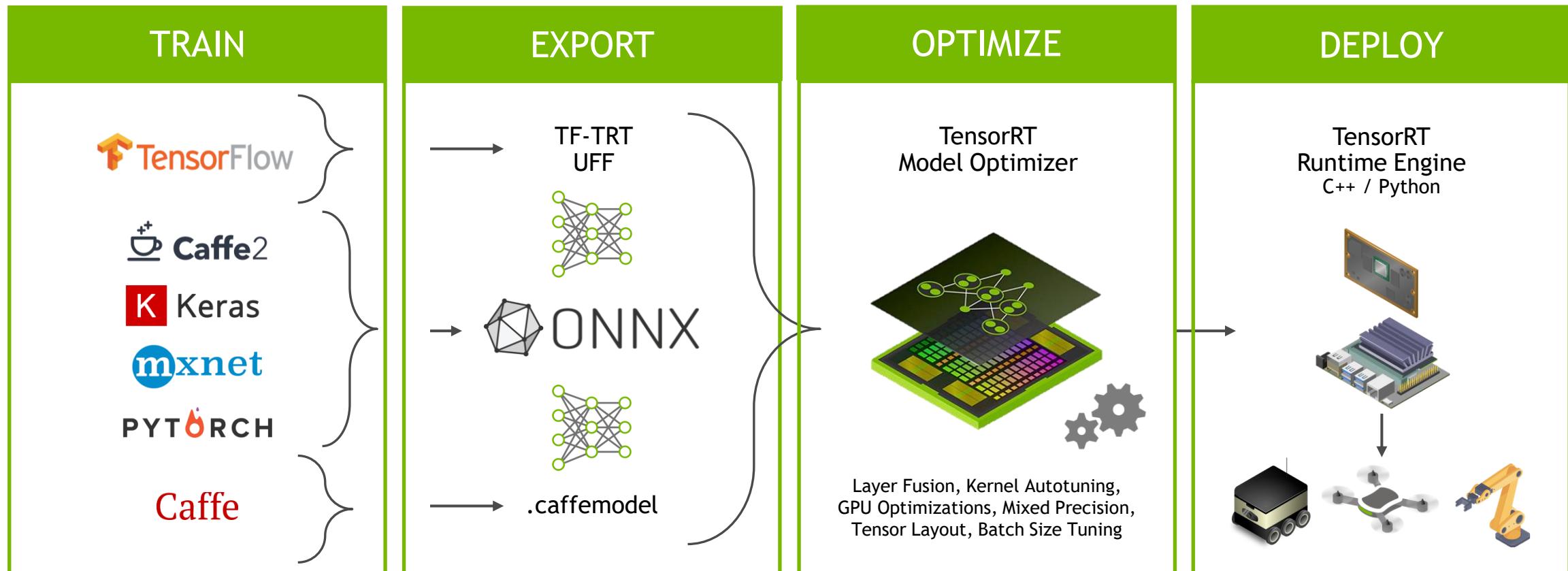
[View Labels](#) [Pull Tag](#)

Gaze Demo for Jetson/L4T Container

Gaze Demo container showcasing gaze detection running on Jetson.

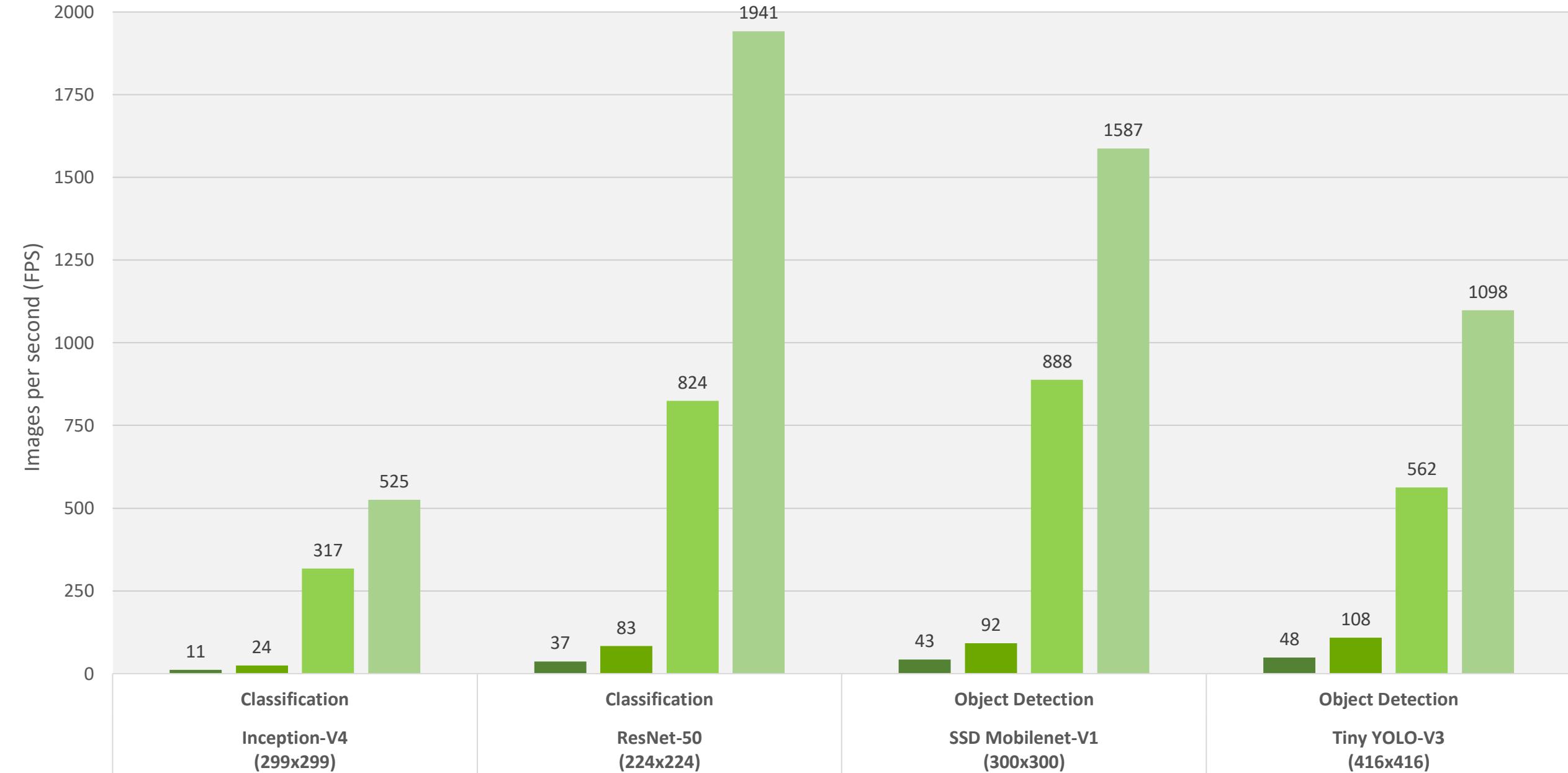
[View Labels](#) [Pull Tag](#)

NVIDIA TensorRT



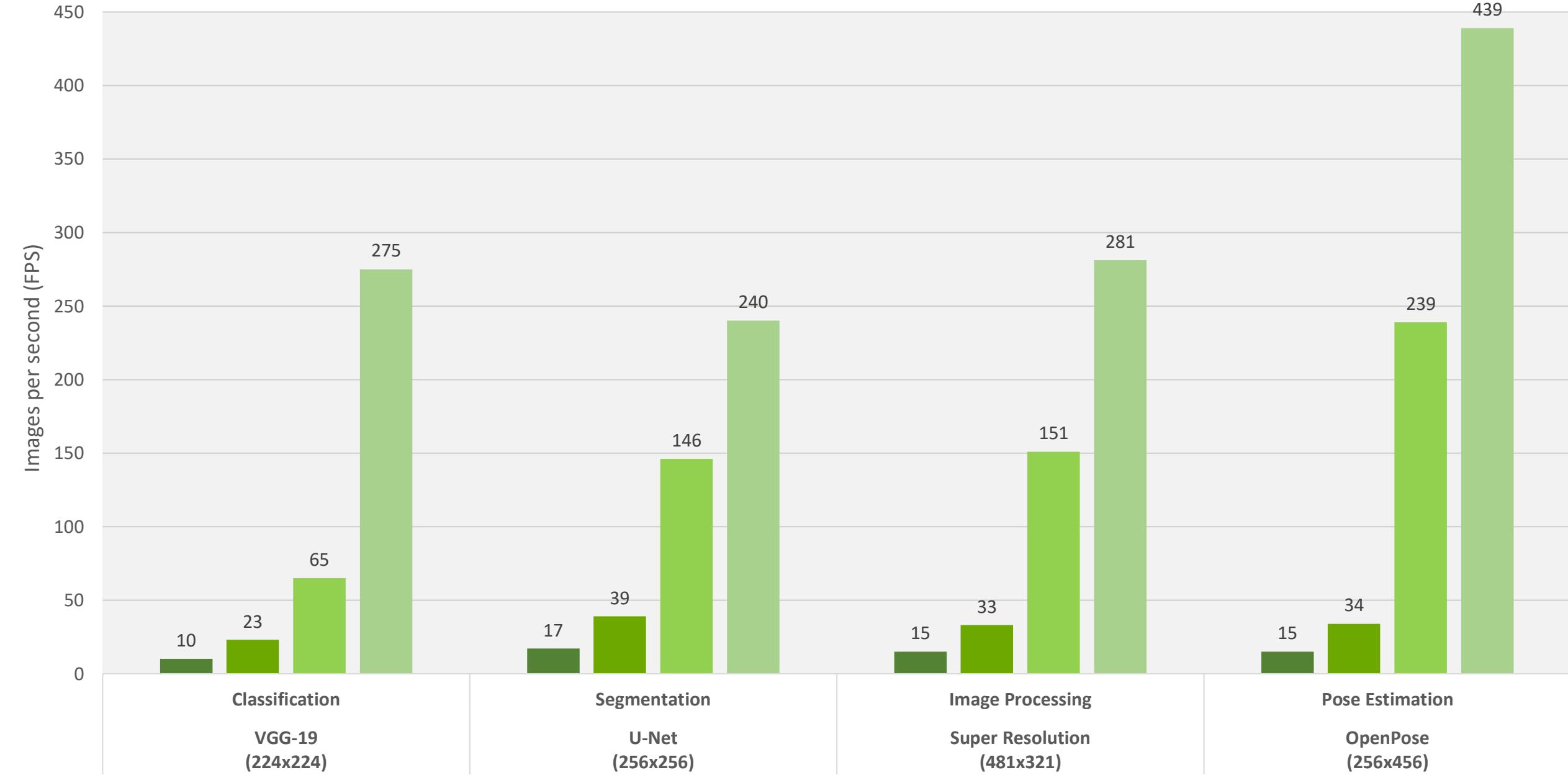
Deep Learning Inference Performance

■ Jetson Nano ■ Jetson TX2 ■ Jetson Xavier NX ■ Jetson AGX Xavier



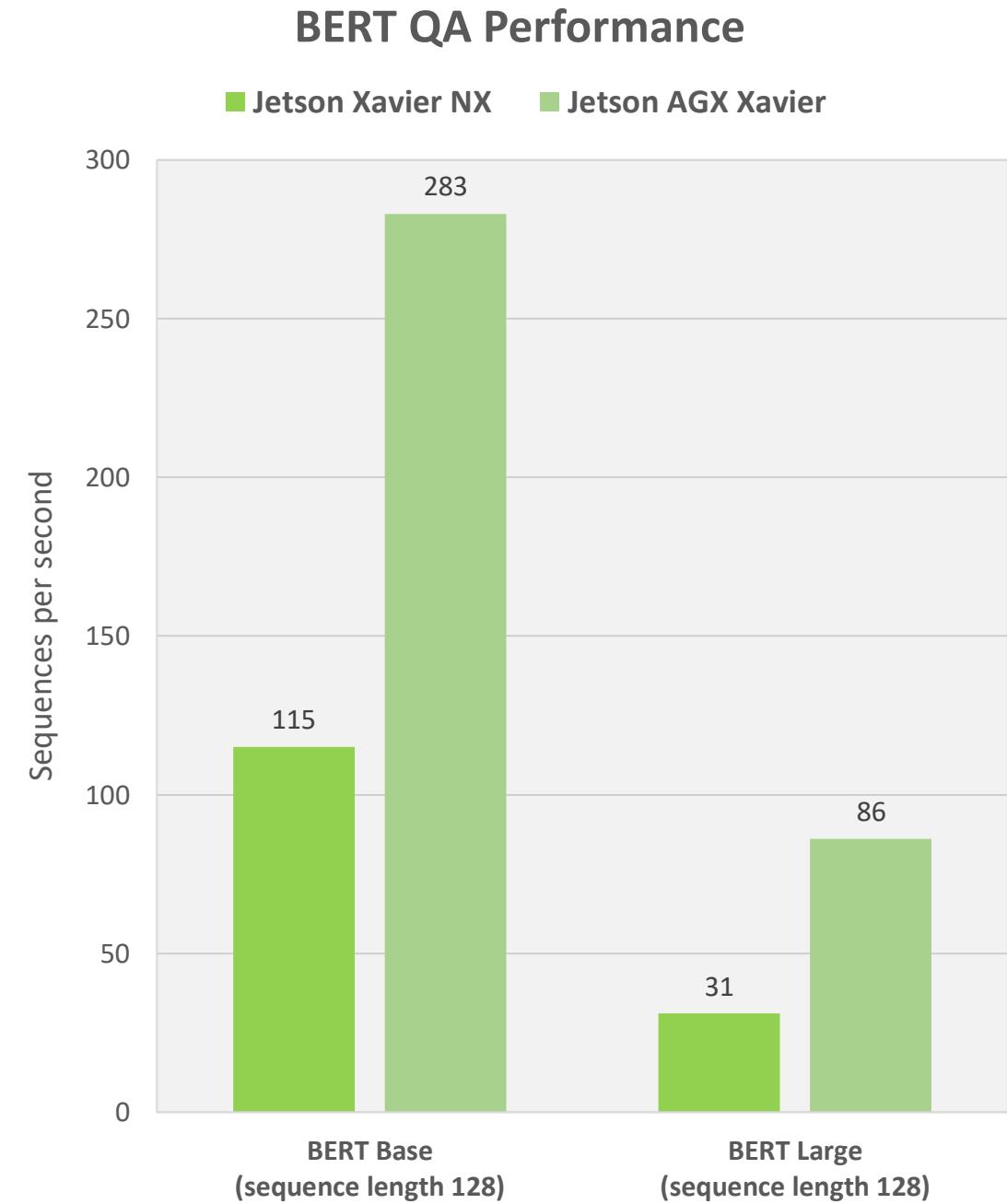
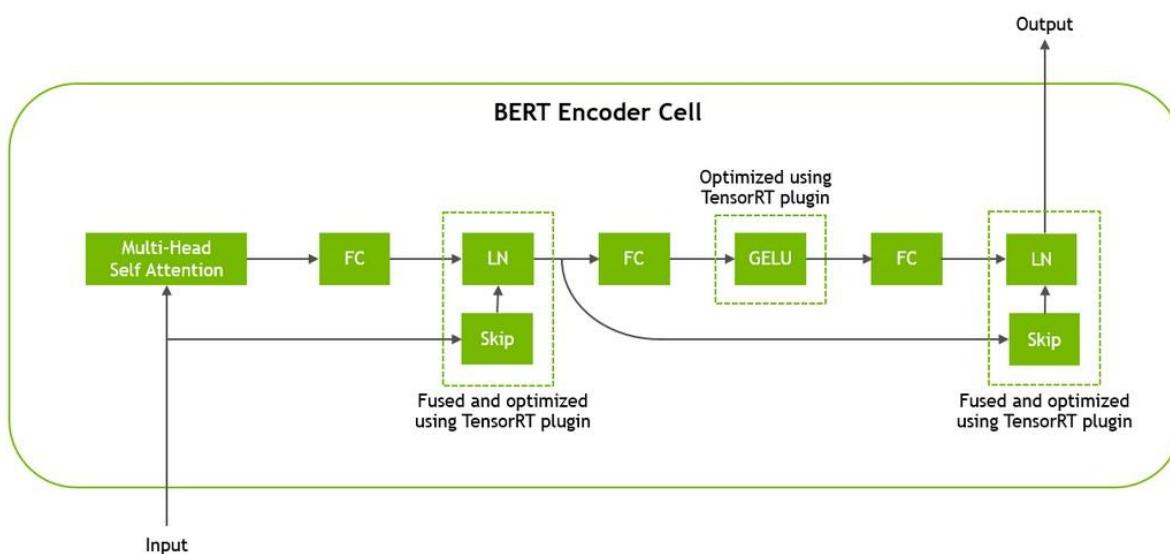
Deep Learning Inference Performance

■ Jetson Nano ■ Jetson TX2 ■ Jetson Xavier NX ■ Jetson AGX Xavier

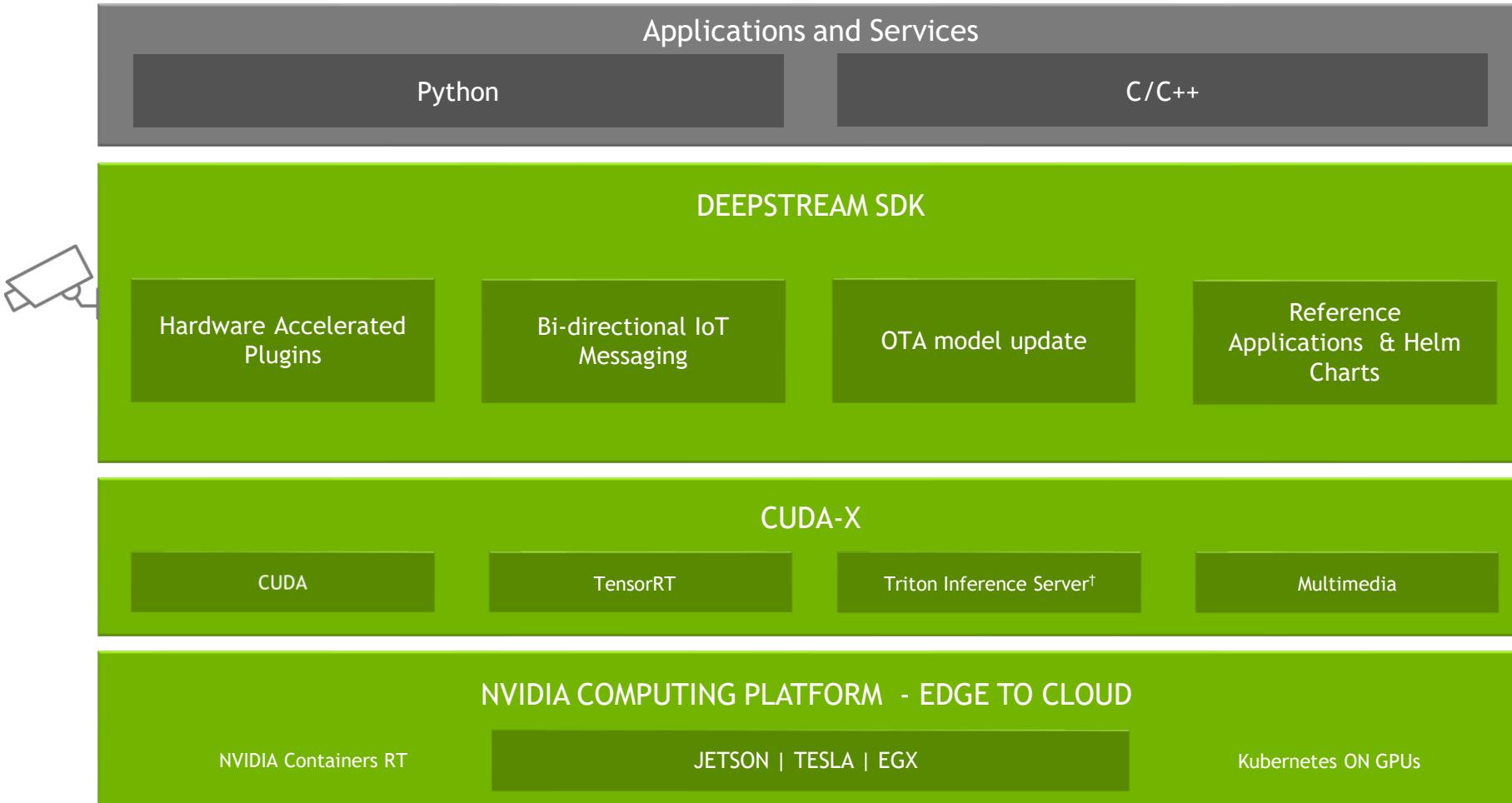


BERT at the Edge

- NLP for HMI (Human-Machine Interface)
 - Question Answering (QA)
 - Intent Classification
 - Sentiment Analysis
 - Name / Entity Recognition
 - Language Translation
- Demo container also supports streaming ASR (QuartzNet)
- Can run Conversational AI stack locally with TensorRT

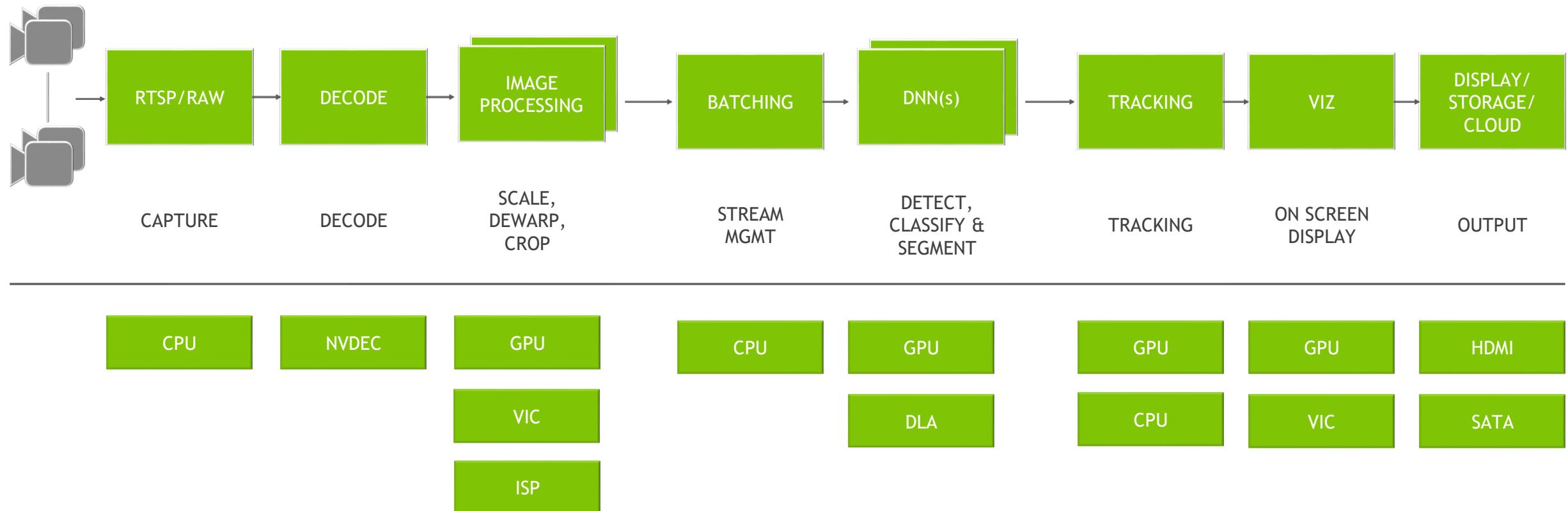


DEEPSTREAM SOFTWARE STACK



[†] - Formerly TensorRT Inference Server

DEEPSTREAM GRAPH ARCHITECTURE



DEEPSTREAM 5.0

New Features

USABILITY



API support for Python
Smart Record, new apps

AI INFERENCE



Integration with NVIDIA Triton
inference server and TLT

IoT

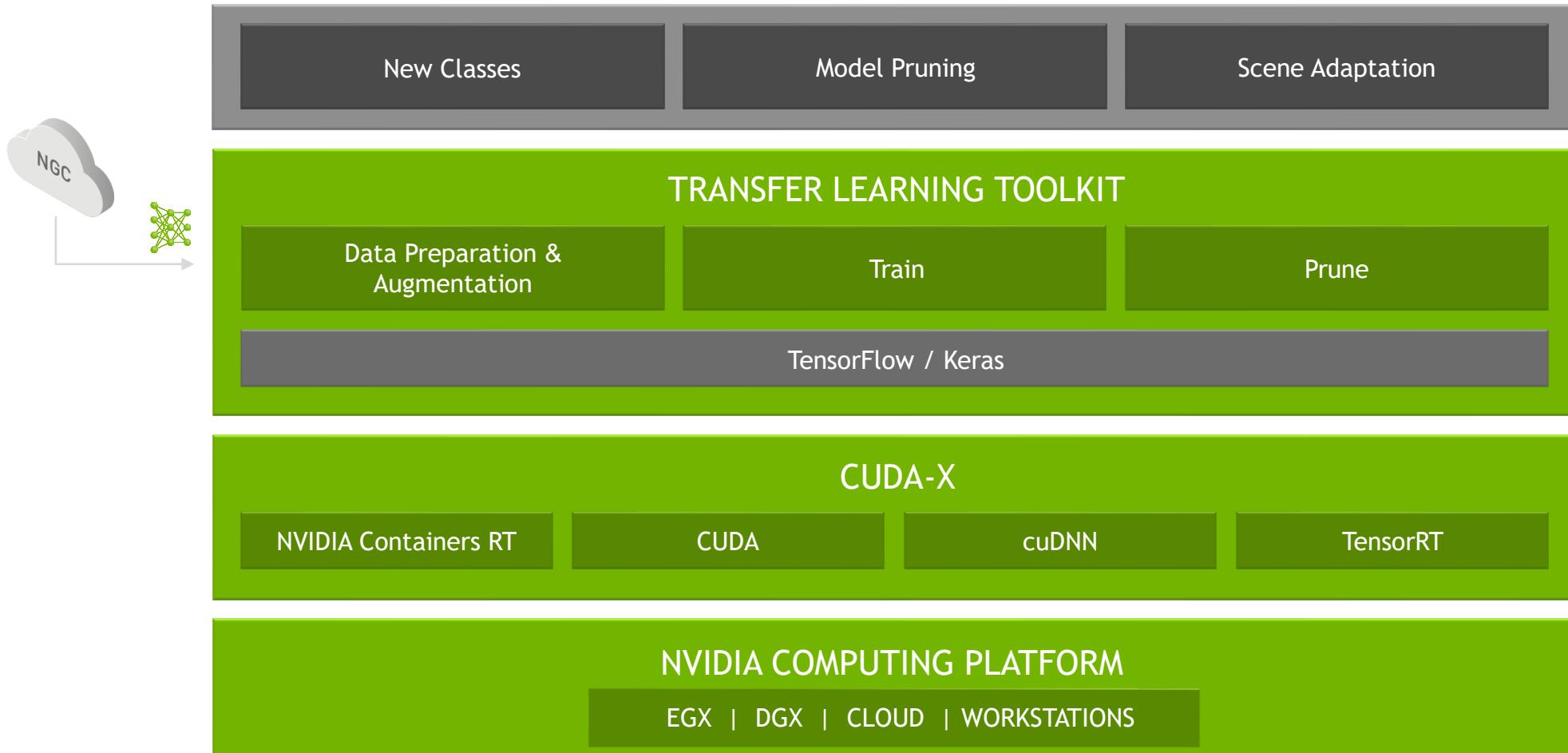


Bi-directional messaging,
OTA model update, Security

[Developer Blog](#)

Building Intelligent Video Analytics Apps Using NVIDIA DeepStream 5.0

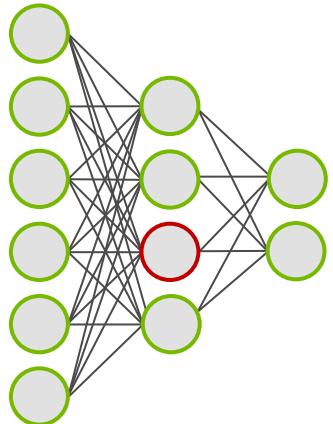
NVIDIA TRANSFER LEARNING TOOLKIT (TLT)



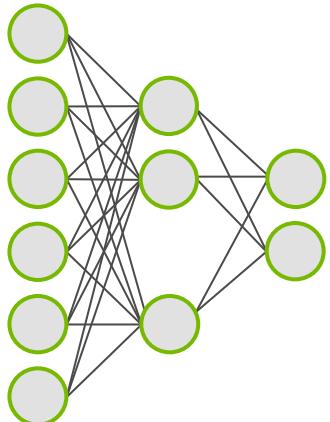
MODEL PRUNING

2 Step Process

- 1 Reduce model size
- 2 Incrementally retrain model after pruning to recover accuracy

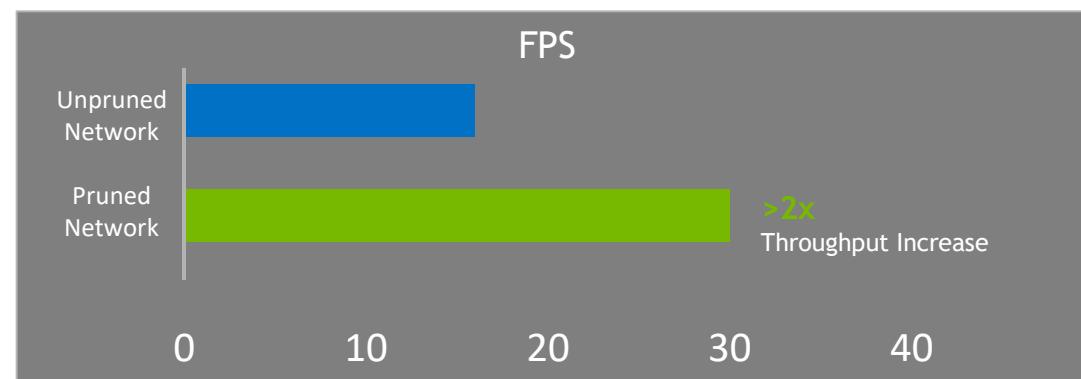
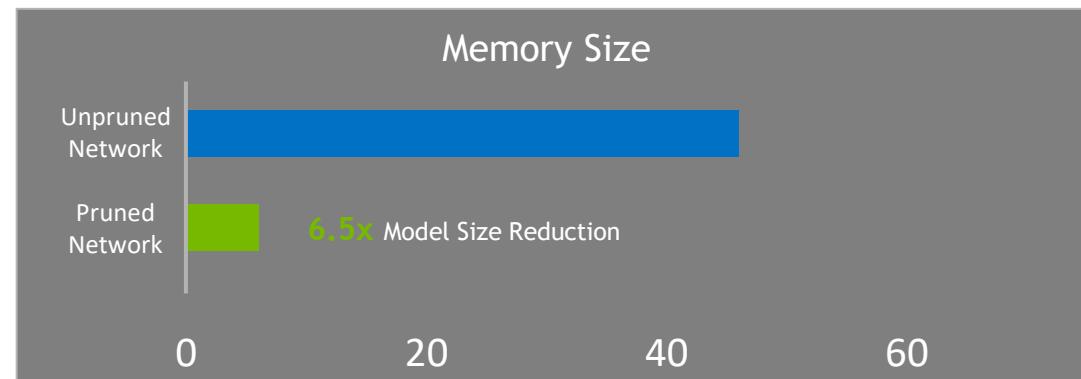


6 inputs, 6 neurons, 32 connections



6 inputs, 5 neurons, 24 connections

Network - ResNet18 4-class



TRANSFER LEARNING TOOLKIT 2.0

	Image Classification	Object Detection						Instance Segmentation
		DetectNet_V2	FasterRCNN	SSD	YOLOV3	RetinaNet	DSSD	MaskRCNN †
ResNet 10/18/34/50/101	✓	✓	✓	✓	✓	✓	✓	✓
VGG16/19	✓	✓	✓	✓	✓	✓	✓	✓
GoogLeNet	✓	✓	✓	✓	✓	✓	✓	✓
MobileNet V1/V2	✓	✓	✓	✓	✓	✓	✓	
SqueezeNet	✓	✓		✓	✓	✓	✓	
DarkNet 19/53†	✓	✓	✓	✓	✓	✓	✓	

† - Available in TLT 2.0 GA

Models trained on google open images public dataset
Available to download on ngc.nvidia.com

PURPOSE BUILT PRE-TRAINED NETWORKS

Highly Accurate | Re-Trainable | Out of Box Deployment



PeopleNet

Number of classes: 3
Dataset: 750k frames
Accuracy: 84%



VehicleTypeNet

Number of classes: 12
Dataset: 56k frames
Accuracy: 88%



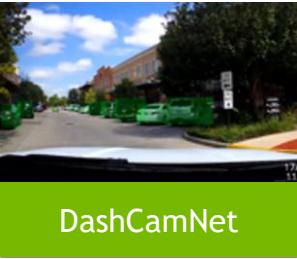
TrafficCamNet

Number of classes: 4
Dataset: 150k frames
Accuracy: 84%



VehicleMakeNet

Number of classes: 20
Dataset: 60k Frames
Accuracy: 92%



DashCamNet

Number of Classes: 4
Dataset: 160k frames
Accuracy: 84%



FaceDetect-IR

Number of classes: 1
Dataset: 600k images
Accuracy: 95%

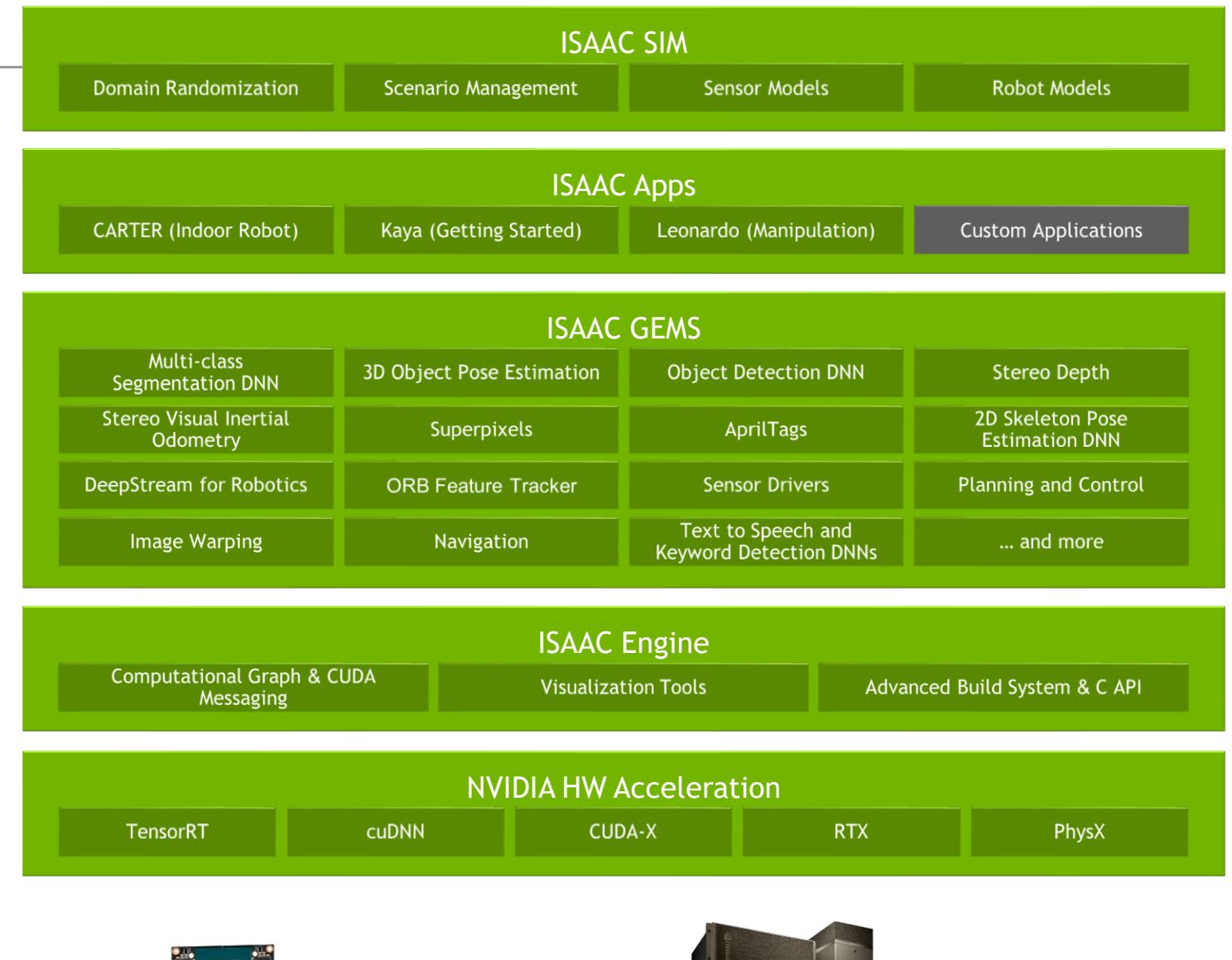
NVIDIA ISAAC

Isaac Engine

Isaac GEMS

Reference Designs

Isaac Sim



NVIDIA Jetson

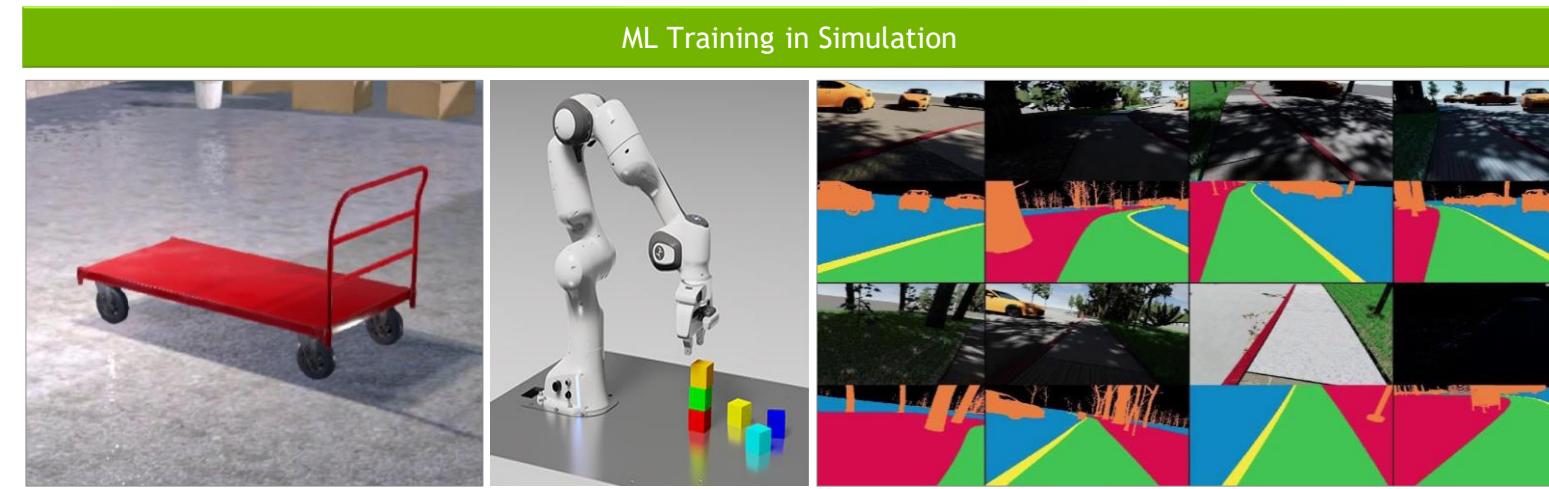


NVIDIA DGX

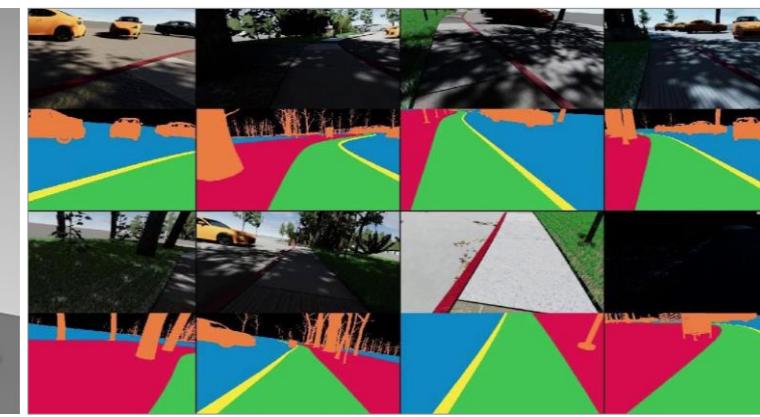
ISAAC SIM



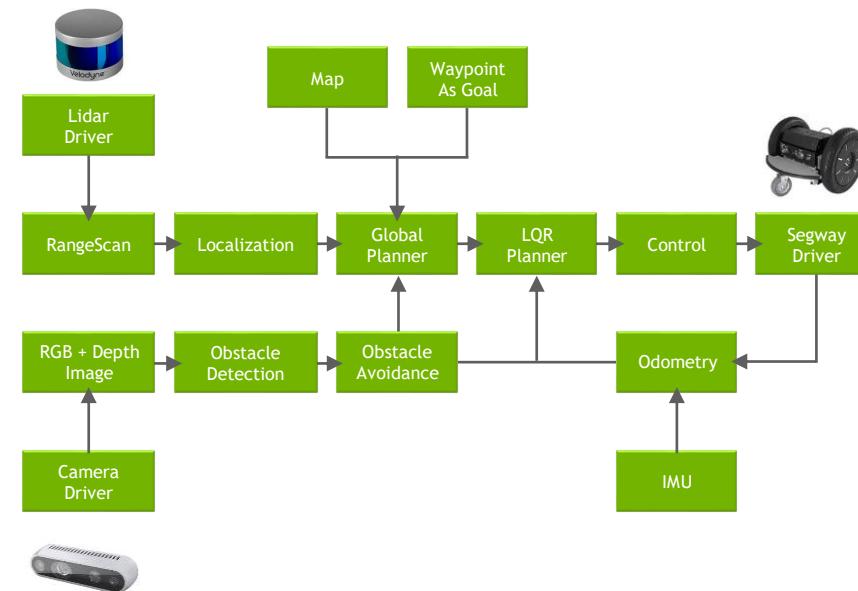
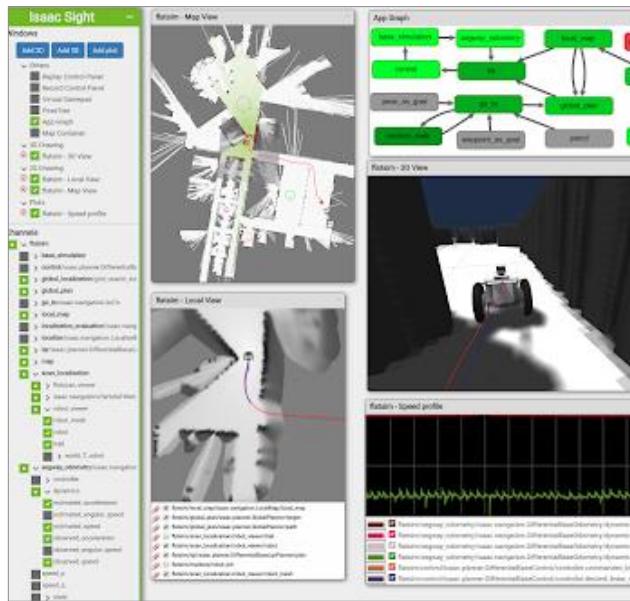
Multiple Carter robots operating simultaneously in virtual warehouse; Each operated by an independent Jetson Xavier



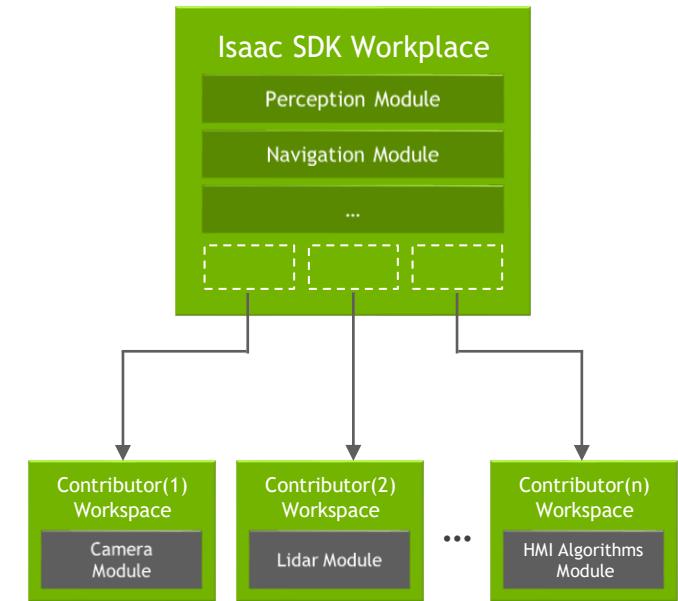
Simulated objects with domain randomization used to train object detection and pose estimation neural networks



HIL



Computational Graph & CUDA Messaging



Advanced Build System & C/Python API

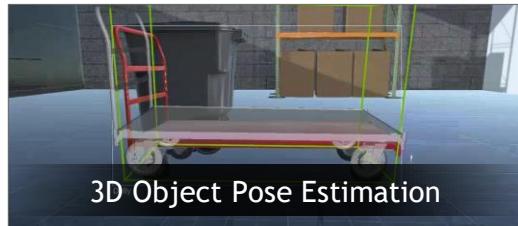
ISAAC ENGINE

ISAAC GEMS

GPU Accelerated Algorithms/DNNs



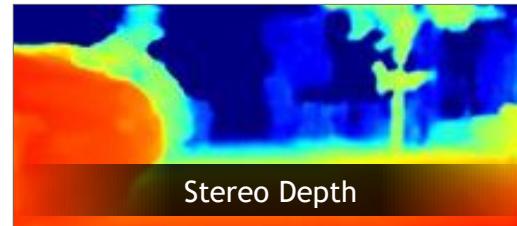
Free Space Segmentation



3D Object Pose Estimation



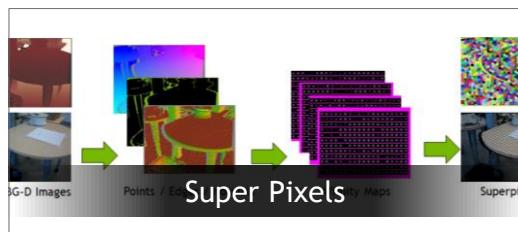
Object Detection



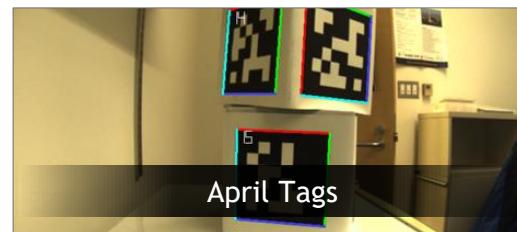
Stereo Depth



Stereo Visual Inertial Odometry



Super Pixels



April Tags



2D Skeleton Pose Estimation



DeepStream Integration



ORB Feature Tracker



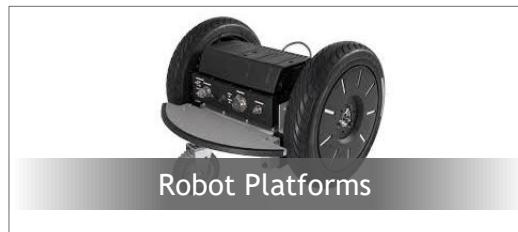
Image Dewarping



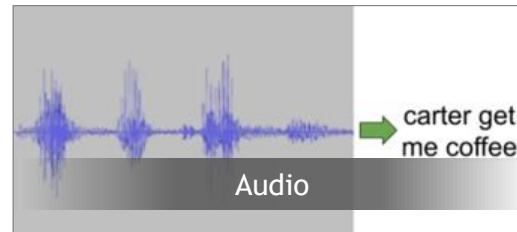
Navigation (LQR Path Planner)



Sensors



Robot Platforms



Audio

And more...



What's new in Isaac SDK 2020.1

Coming on May 26, 2020

- 3D Object Pose Estimation Using Depth Image.
 - Manipulator Motion Planning.
 - Multi-LIDAR Robot localization and obstacle avoidance; Planner with cost-maps; Stereo Visual Inertial Odometry.
-
- Virtual Factory of Future to Train/Test/Visualize/Debug Robotics.
 - Reinforcement Learning Framework & Example.
 - Docker Container for Supervised Learning using Isaac Sim.
-
- Python API for Isaac GEMs and Applications.
-
- Laikago Quadruped Robot reference application.

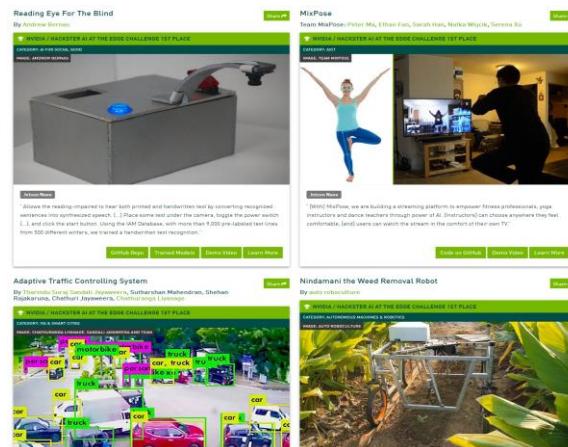


GETTING STARTED TIPS & TRICKS

JETSON RESOURCES

The screenshot shows the NVIDIA Jetson Developer Zone homepage. It features a large banner for the JetPack SDK, followed by sections for "Meet Jetson, the Platform for AI at the Edge.", "Highlights" (including the Jetson Nano Developer Kit), and "Get Started with NVIDIA Jetson". A navigation bar at the bottom includes links for BUY, DOWNLOAD, TUTORIALS, RESOURCES, FAQ, FORUM, and ECOSYSTEM.

Jetson Developer Zone



Projects

The screenshot shows the NVIDIA Developer forums interface. It displays a list of topics under categories like AUTONOMOUS MACHINES, JETSON & EMBEDDED SYSTEMS, and JETSON XAVIER NX. Topics include "NVIDIA announces Jetson Xavier NX", "Upcoming Jetson Xavier NX webinars on 5/20 and 5/26", and "Jetson Xavier NX available to order now". The interface includes filters for RECENT, VOTES, and ACTIVITY.

Developer Forums

The screenshot shows the Jetson Zoo page, which lists various software components for Jetson. It includes sections for Core Components (TensorFlow, PyTorch, Caffe2, etc.), Machine Learning (TensorFlow, PyTorch, Caffe2, etc.), and Docker Containers (TensorFlow, PyTorch, etc.). A TensorFlow logo is visible at the bottom.

Jetson Zoo

The screenshot shows the eLinux Wiki page for NVIDIA Jetson modules. It compares five models: Jetson Nano, Jetson TX1, Jetson TX2 series, Jetson Xavier NX, and Jetson AGX Xavier. Each model is shown with its respective hardware components and specifications. A table at the bottom provides a detailed comparison of their CPU, GPU, memory, and other features.

eLinux Wiki



Ecosystem

Jetson Community Projects

Explore and learn from Jetson projects created by us and our community. These projects have been built for Jetson Nano, Jetson AGX Xavier, and Jetson TX2. Scroll down to see projects with code, videos and more.

Project of the Month

Have a Jetson project to share? Post it on [our forum](#) for a chance to be featured here too. Every month, we'll award one Jetson AGX Xavier Developer Kit to a project that's a cut above the rest for its application, inventiveness and creativity.



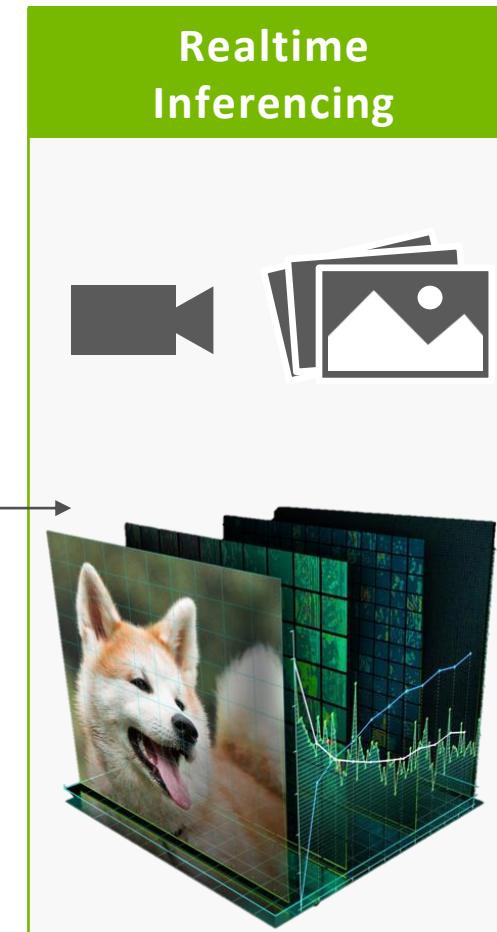
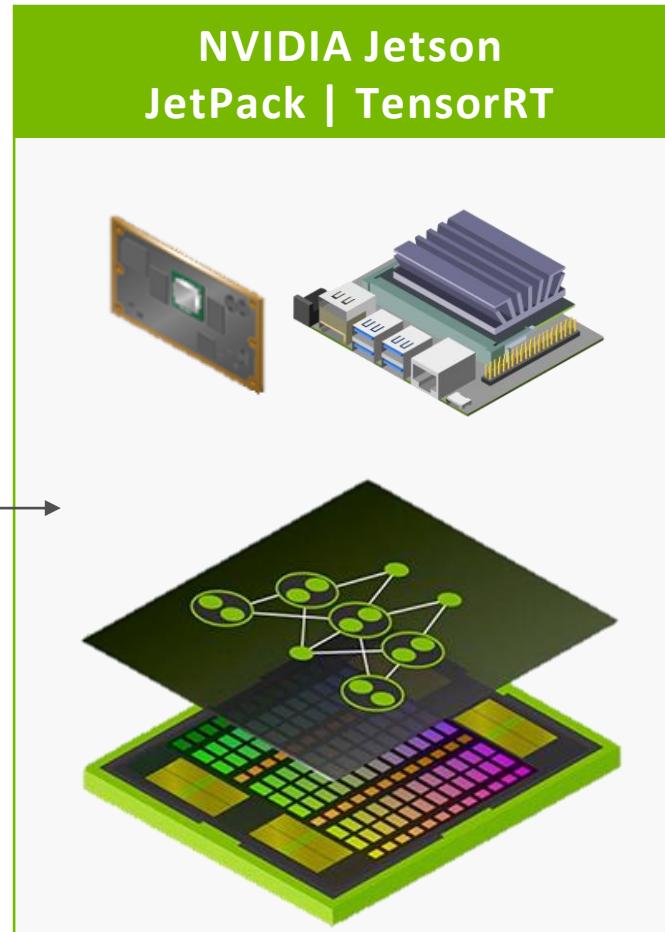
JetsonTV

This is a collection of cool projects, applications, and demos that use NVIDIA Jetson platform. For more inspiration, code and instructions, scroll below.

Gallery

HELLO AI WORLD

Getting Started with Deep Learning



HELLO AI WORLD

Realtime Object Detection in 10 Lines of Python

```
import jetson.inference
import jetson.utils

net = jetson.inference.detectNet("ssd-mobilenet-v2")
camera = jetson.utils.gstCamera()
display = jetson.utils.glDisplay()

while display.IsOpen():
    img, width, height = camera.CaptureRGBA()
    detections = net.Detect(img, width, height)
    display.RenderOnce(img, width, height)
```

Also supports:

- Classification, Segmentation
- 40 Pre-Trained TensorRT Models
- Transfer Learning with PyTorch

github.com/dusty-nv/jetson-inference



SYSTEM SETUP



- Device is booted from a MicroSD card
 - 32GB UHS-1 recommended minimum
- Download the SD card image from NVIDIA.com
- Flash the SD card image with Etcher program
 - From a Windows/Mac/Linux PC
 - JetPack updates can be installed without re-flashing
- Insert the MicroSD card into the slot located on the underside of the Jetson Xavier NX module
- Connect keyboard/mouse/display, or Micro-USB to PC (headless)
- Board will boot up when included power supply is attached
 - Green power LED will light

POWER MODES

	10W Mode	15W Mode
Performance	14 TOPS (INT8)	21 TOPS (INT8)
CPU	2-core @ 1500MHz 4-core @ 1200MHz	2-core @ 1900MHz 4/6-core @ 1400Mhz
GPU	384 CUDA Cores, 48 Tensor Cores @ 800MHz	384 CUDA Cores, 48 Tensor Cores @ 1100MHz
DLA	Dual NVDLA engines @ 900MHz	Dual NVDLA engines @ 1100MHz
Memory	8GB 128-bit LPDDR4x @ 1600MHz 51.2GB/s	

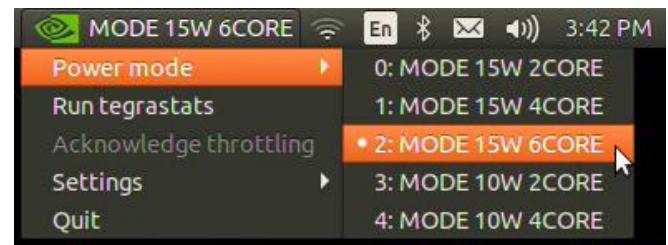
see [L4T Documentation](#) for full power mode table

NVIDIA Power Model Tool

`sudo nvpmode -q` (for checking the active mode)

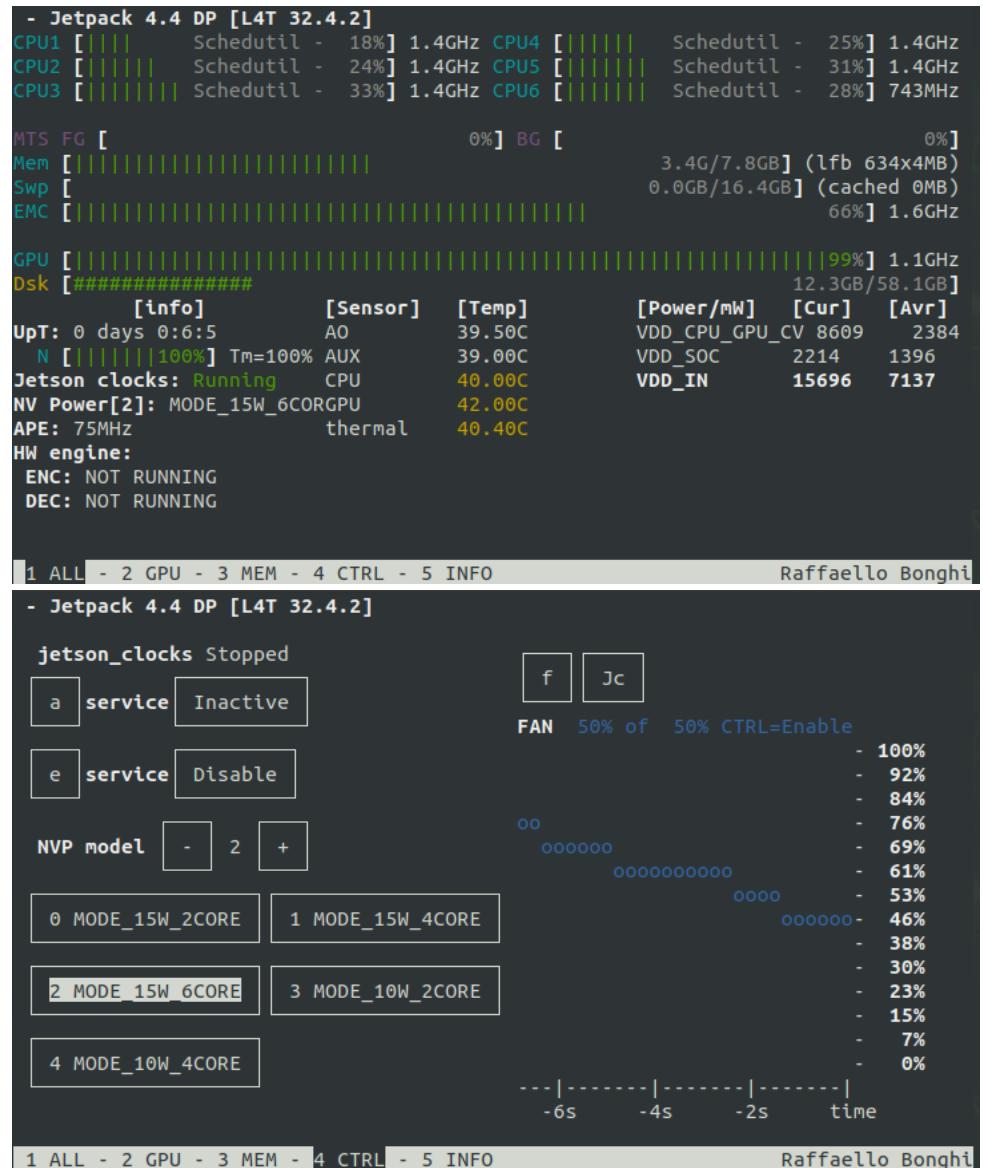
`sudo nvpmode -m 2` (for changing mode, persists after reboot)

`sudo jetson_clocks` (to disable DVFS and lock clocks to max for active mode)

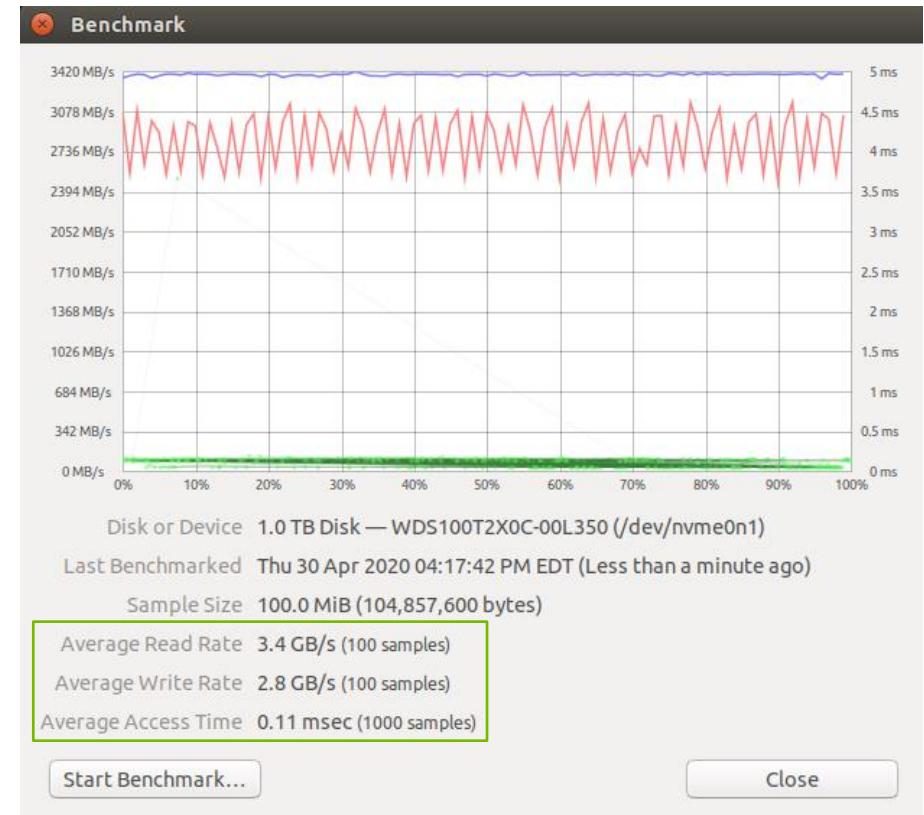
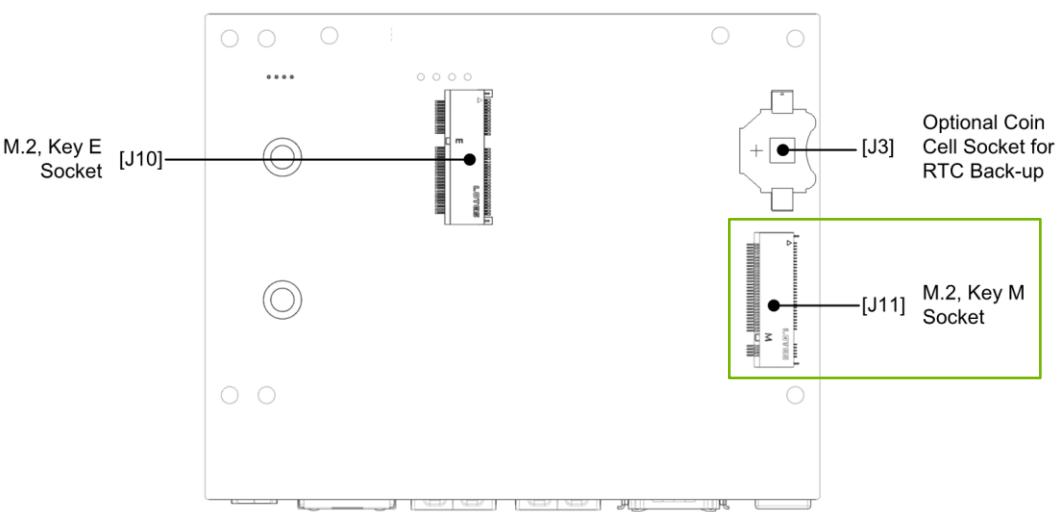
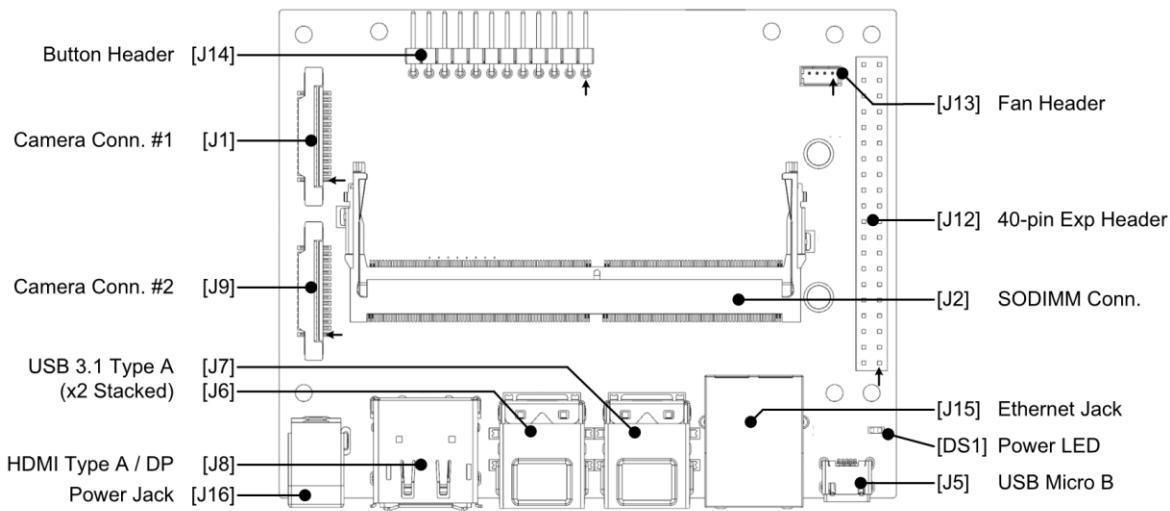


PERFORMANCE MONITORING

- **tegrastats**
 - Reports CPU/GPU/Memory utilization and frequencies, encoder/decoder utilization, thermals, power consumption
 - See [L4T Documentation](#) for description of statistics
 - Run as: `sudo tegrastats`
 - **jtop**
 - https://github.com/rbonghi/jetson_stats
 - TUI interface to tegrastats / nvpmodel
 - `sudo pip install jetson-stats`
 - On-module temperature/power sensors
 - Thermal zones for CPU, GPU, AUX, PMIC
 - Rail voltage/current VDD_IN, VDD_CPU_GPU_CV, VDD_SOC
 - see [Jetson Xavier NX Thermal Design Guide](#)

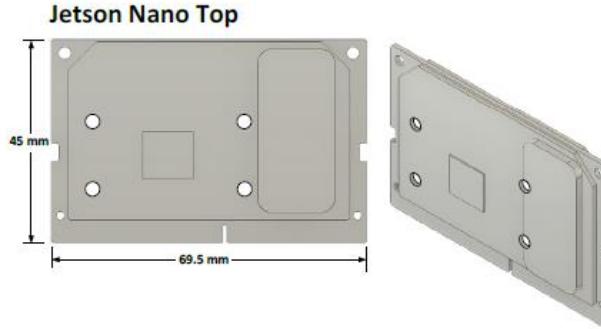
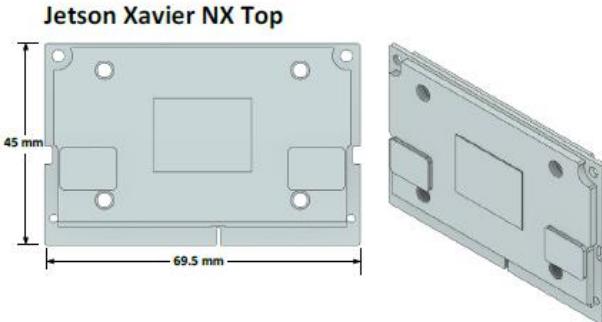


NVMe STORAGE



NANO → NX MIGRATION

NVIDIA Jetson Xavier NX and Jetson Nano Interface Comparison and Migration App Note



	NX Module	Nano Module
PCIe	1x4 (Gen4 - Root Port & Endpoint) 1x1 (Gen3 - Root Port)	1x4 (Gen2 - Root Port) -
Display	(2x) multi-mode HDMI 2.0a / DP 1.4 / eDP 1.4 -	HDMI 2.0 or DP 1.2, eDP 1.4 DSI 1x2
Camera	14 lanes (3x4 or 6x2) MIPI CSI-2 D-PHY 1.2 (2.5 Gb/s per pair)	12 lanes (3x4 or 4x2) MIPI CSI-2 D-PHY 1.1 (1.5 Gb/s per pair)
USB 3.x	USB 3.1 (Gen2)	USB 3.0 (Gen1)
CAN	1x	-
JTAG	-	On-module test points only

NX SYSTEMS



AAEON 825AI



ADLINK DLAP-211-JNX



Advantech MIC-710AIX



AIMobile NC-X1



Auvidea JN30C-LC



AVerMedia EN713-DD



ConnectTech Rudi-NX



Diamond Systems
JETBOX-FLOYD-XNX-01



Leetop UCORE-A203



Leopard Imaging
LI-XNX-BOX-MIPI



MIIVII Lite NX



Realtimes RTSS-Z506

JETSON ECOSYSTEM

DISTRIBUTION



SOFTWARE



HW AND SENSORS



Thank you!



Developer Site

developer.nvidia.com/jetson

Getting Started

nvidia.com/JetsonXavierNX-Start

Support Forums

forums.developer.nvidia.com

Hello AI World

github.com/dusty-nv

Visit the Wiki

eLinux.org/Jetson

Up Next: Q&A

The screenshot shows a blog post on the NVIDIA Developer website. The title is "Bringing Cloud-Native Agility to Edge AI Devices with the NVIDIA Jetson Xavier NX Developer Kit". The post is dated May 8, 2020, and includes a summary of the kit's capabilities, mentioning up to 21 TOPS of compute, 15W power, and support for Docker containers. It also highlights the Xavier SoC's ability to run multiple complex models and sensor streams. A bulleted list details the hardware components: an integrated Volta GPU, two Deep Learning Accelerator engines, a VLIW Vision Accelerator, a Carmel ARMv8 CPU, and 8-GB LPDDR4x memory. The post concludes by mentioning cloud-native technologies like Docker-based containerization and Kubernetes.

AUTONOMOUS MACHINES

Bringing Cloud-Native Agility to Edge AI Devices with the NVIDIA Jetson Xavier NX Developer Kit

By Dustin Franklin, Suhas Hariharapura Sheshadri and Sarah Todd | May 8, 2020

Tags: Cloud native, cloud-native, containerization, CUDA, cuDNN, DeepStream, developer preview, Jetpack, Jetson, microservice architecture, NGC, NVIDIA GPU Cloud, orchestration, System on a Chip, TensorRT, Volta GPU

Today, NVIDIA announced the [NVIDIA Jetson Xavier NX Developer Kit](#), which is based on the [Jetson Xavier NX](#) module. Delivering up to 21 TOPS of compute in a compact form factor with under 15W of power, Jetson Xavier NX brings server-level performance and cloud-native workflows to edge AI devices and autonomous machines.

With the Jetson Xavier NX Developer Kit, you can create amazing AI-powered applications and quickly deploy deep neural network (DNN) models and popular machine learning frameworks into the field. Initial software support from [NVIDIA JetPack 4.4 Developer Preview](#) includes CUDA Toolkit 10.2 and preview releases of cuDNN 8.0, TensorRT 7.1, and DeepStream 5.0, along with new Docker containers for machine learning and pretrained DNN models.

Jetson Xavier NX is based on NVIDIA's groundbreaking Xavier SoC that can run multiple complex models and multiple high-definition sensor streams in parallel. It includes the following features:

- An integrated NVIDIA Volta 384-core Volta GPU with 48 Tensor Cores
- Two NVIDIA Deep Learning Accelerator engines
- Seven-way VLIW Vision Accelerator
- Six-core NVIDIA Carmel 64-bit ARMv8.2 CPU
- 8-GB 128-bit LPDDR4x

To further streamline the deployment of edge AI applications in production environments, NVIDIA has brought cloud-native technologies to Jetson, including Docker-based containerization with hardware passthrough and orchestration services like Kubernetes, along with pretrained models and container images available from the [NVIDIA NGC](#) registry.

Jetson Xavier NX Developer Kit

The Jetson Xavier NX Developer Kit bundles an open-source [reference carrier board](#) and pre-assembled heatsink/fan as shown in Figure 2, including a 19V power supply and M.2-based 802.11 WLAN+BT module. In addition to the bootable microSD card slot, an M.2 Key-M NVMe socket is provided on the underside of the carrier for expanded high-speed storage.

Because the Xavier NX module is backwards-compatible with Jetson Nano (B01), their carrier boards share some commonality—also included are dual MIPI CSI camera connectors, along with four USB 3.1 ports, HDMI, DisplayPort, Gigabit Ethernet, and a 40-pin GPIO header.

The key features and interfaces of the kit's carrier board are shown below in Table 1. For more information about the core processing capabilities and specifications of the Jetson Xavier NX compute module, see the [Introducing Jetson Xavier NX, the World's Smallest AI Supercomputer](#) post and the [Jetson Xavier NX Module Data Sheet](#).

Dev Blog *Bringing Cloud-Native Agility to Edge AI Devices with NVIDIA Jetson Xavier NX Developer Kit*