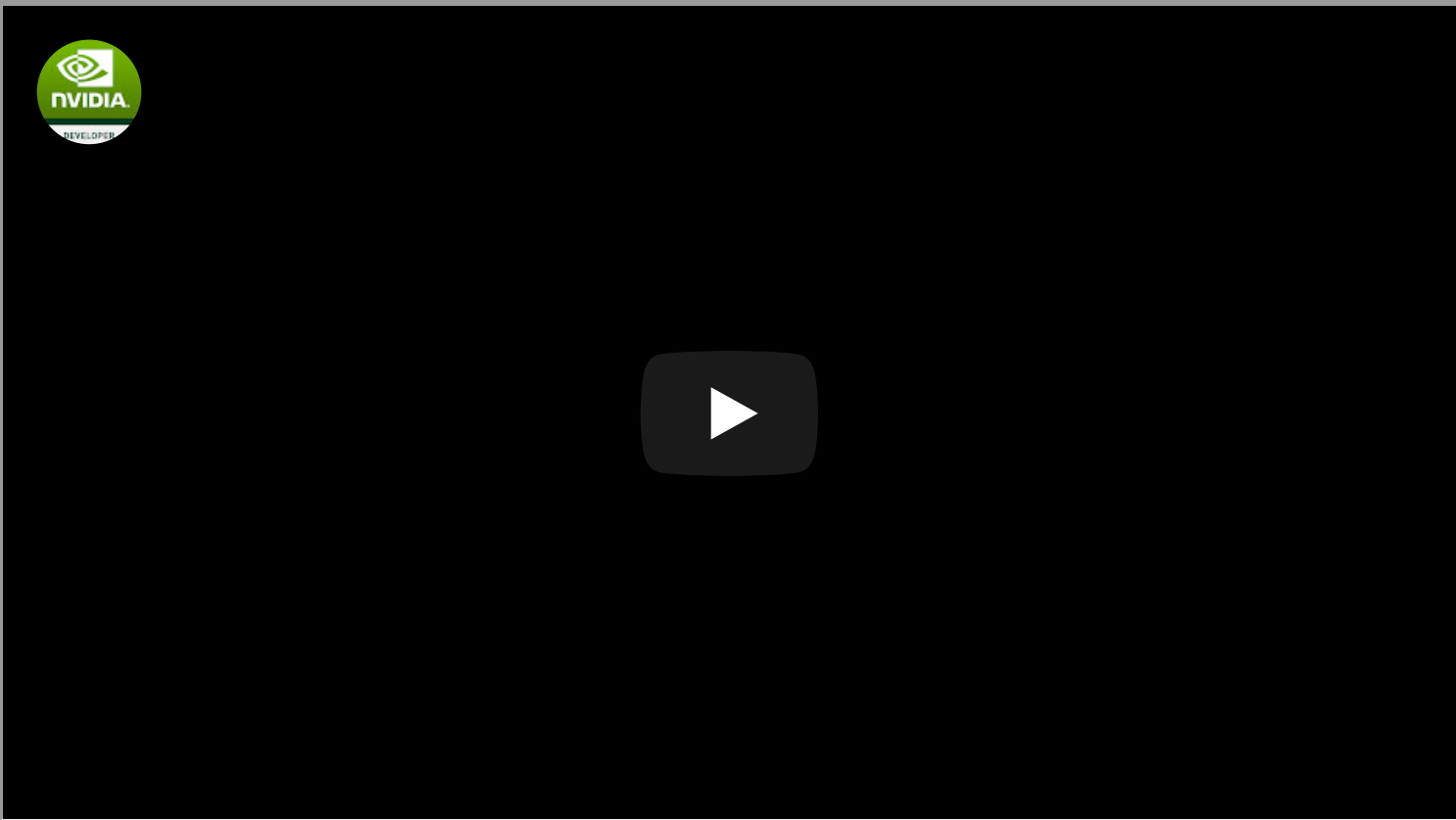


Clara Medical Imaging (<https://www.nvidia.com/en-us/healthcare/>) is a collection of developer toolkits built on NVIDIA’s compute platform aimed at accelerating compute, artificial intelligence, and advanced visualization. Medical imaging industry is being transformed. A decade ago, the earliest applications to take advantage of GPU computing were image & signal processing applications.

Today, GPUs are found in almost all imaging modalities, including CT, MRI, X-ray, and Ultrasound bringing more compute capabilities to the edge devices. Deep Learning research in Medical Imaging is also booming with more efficient and improved approaches being developed to enable AI-assisted workflows. Today, most of this AI research is being done in isolation and with limited datasets which may lead to overly simplified models. Even when a fully validated model is available, it is a challenge to deploy the algorithm in a local environment. With the latest release of Clara AI for Medical Imaging (<https://www.nvidia.com/en-us/healthcare/>) now data scientists, researchers and software developers have the necessary tools, APIs and development framework to train and deploy AI workflows.

Technical Webinar (<https://info.nvidia.com/accelerate-discoveries-with-the-nvidia-clara-ai-toolkit-reg-page.html>)



Clara Train SDK

By clicking the "Download" button, you are confirming that you have read and agree to be bound by the SOFTWARE DEVELOPER KITS, SAMPLES AND TOOLS LICENSE AGREEMENT (<https://developer.nvidia.com/clara-train-eula>) for use of the SDK package. The download will begin immediately after clicking on the "Download"button.

Download Clara Train SDK (<https://ngc.nvidia.com/catalog/containers/nvidia:clara-train-sdk>)

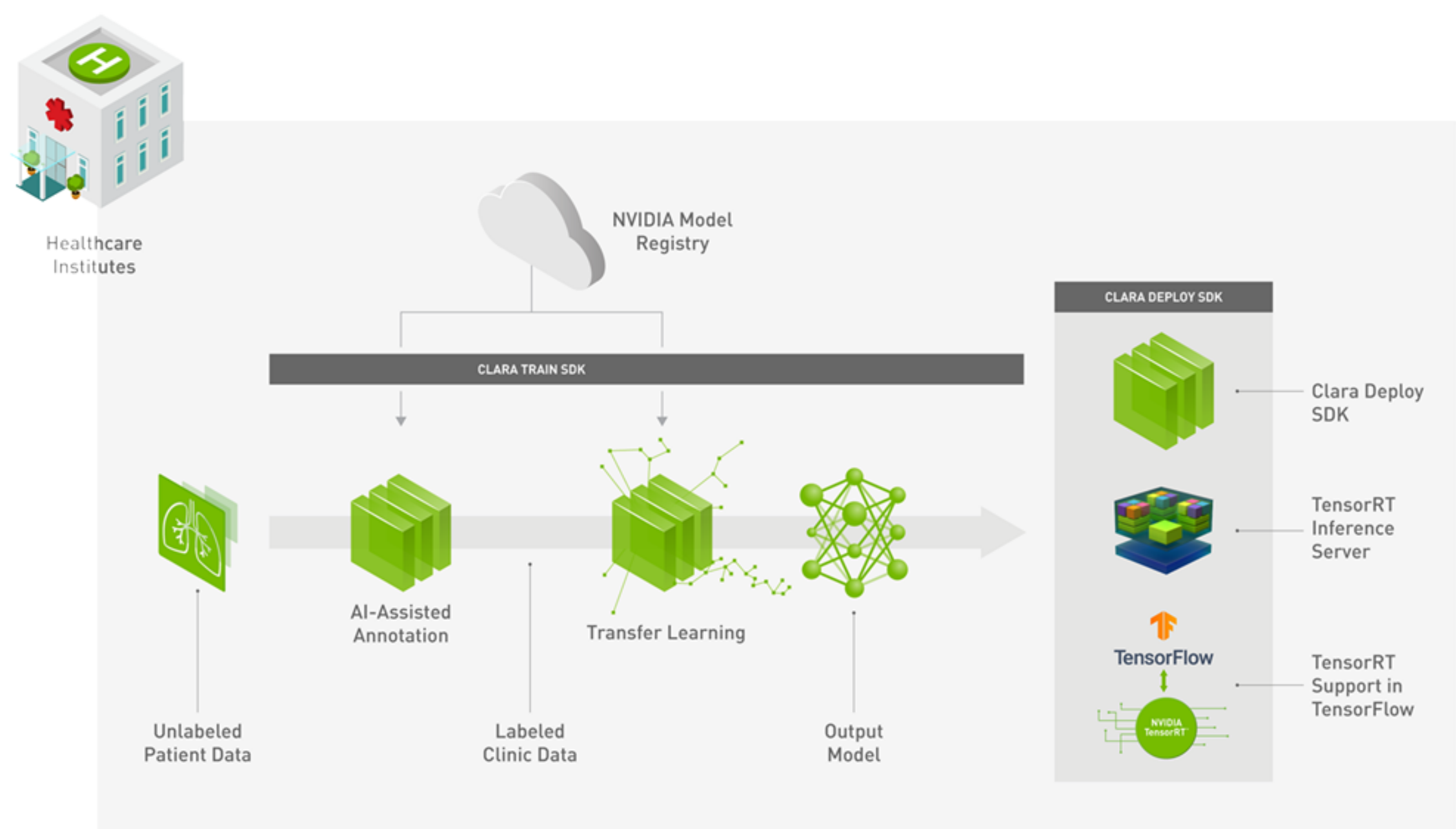
Clara Train SDK Developer Blog (<https://devblogs.nvidia.com/annotate-adapt-model-medical-imaging-clara-train-sdk>)

Clara Deploy SDK

By clicking the "Download" button, you are confirming that you have read and agree to be bound by the SOFTWARE DEVELOPER KITS, SAMPLES AND TOOLS LICENSE AGREEMENT ([https://developer.download.nvidia.com/healthcare/clara/docs/NVIDIA\\_Pre-Release\\_Clara\\_Server\\_Source\\_Code%20\\_12Nov18.pdf](https://developer.download.nvidia.com/healthcare/clara/docs/NVIDIA_Pre-Release_Clara_Server_Source_Code%20_12Nov18.pdf)) for use of the SDK package. The download will begin immediately after clicking on the "Download"button.

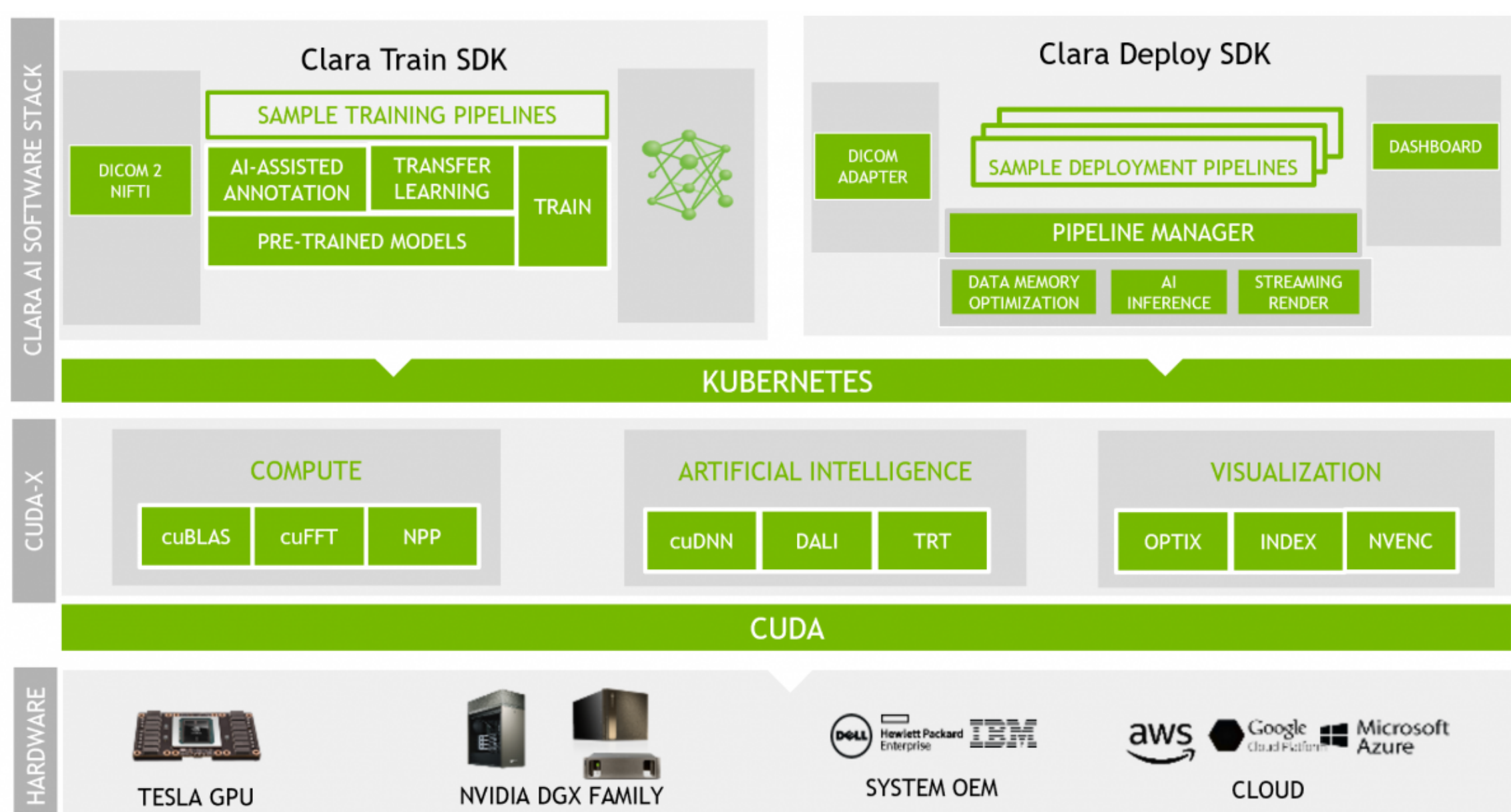
Download Clara Deploy SDK ([https://ngc.nvidia.com/catalog/model-scripts/nvidia:clara\\_deploy\\_sdk](https://ngc.nvidia.com/catalog/model-scripts/nvidia:clara_deploy_sdk))

Clara Deploy SDK Developer Blog (<https://devblogs.nvidia.com/build-manage-and-deploy-ai-enhanced-clinical-workflows-with-clara-deploy-sdk/>)



## Technology Stack

NVIDIA Clara AI technology stack includes systems software libraries that form the foundation of GPU computing and abstracted software tools, containers, and workflow defining pipelines that allow data scientist and medical imaging developers to build and deploy AI for clinical workflows as well as accelerated research in Medical Imaging.



### Clara Train SDK

Clara Train SDK enables data scientists and medical researchers with state of the art tools and technologies that accelerate data annotation, adaptation and development of AI models for Medical Imaging workflows.

Key Capabilities of Clara Train SDK include:

- APIs to add AI-assisted annotation to any medical viewer with new features like Auto-Annotation and interactive annotation modes, Annotation Server which makes pre-trained models available to the client application and client APIs hosted on Github (<https://github.com/NVIDIA/ai-assisted-annotation-client>) that make integration with your Medical viewer application seamless.
  - These capabilities are already integrated into the latest MITK workbench plugin (<http://mitk.org/wiki/MITK>).
- The SDK provides capabilities to use techniques like Transfer learning to adapt or train deep learning models from scratch, enabling Data Scientists to bring their own model architectures and run workflows, this is made possible through a unified foundation of Medical Model

Archive (MMAR)

- The MMAR (Medical Model Archive) provides a model development environment; defines a standard structure for storing and organizing all artifacts produced during the model development life cycle.
- MMAR includes NVIDIA pretrained models based on AH-Net, DenseNet, ResNet, Dextr3D packaged as complete 2D/3D model applications for organ based segmentation, classification and annotation.

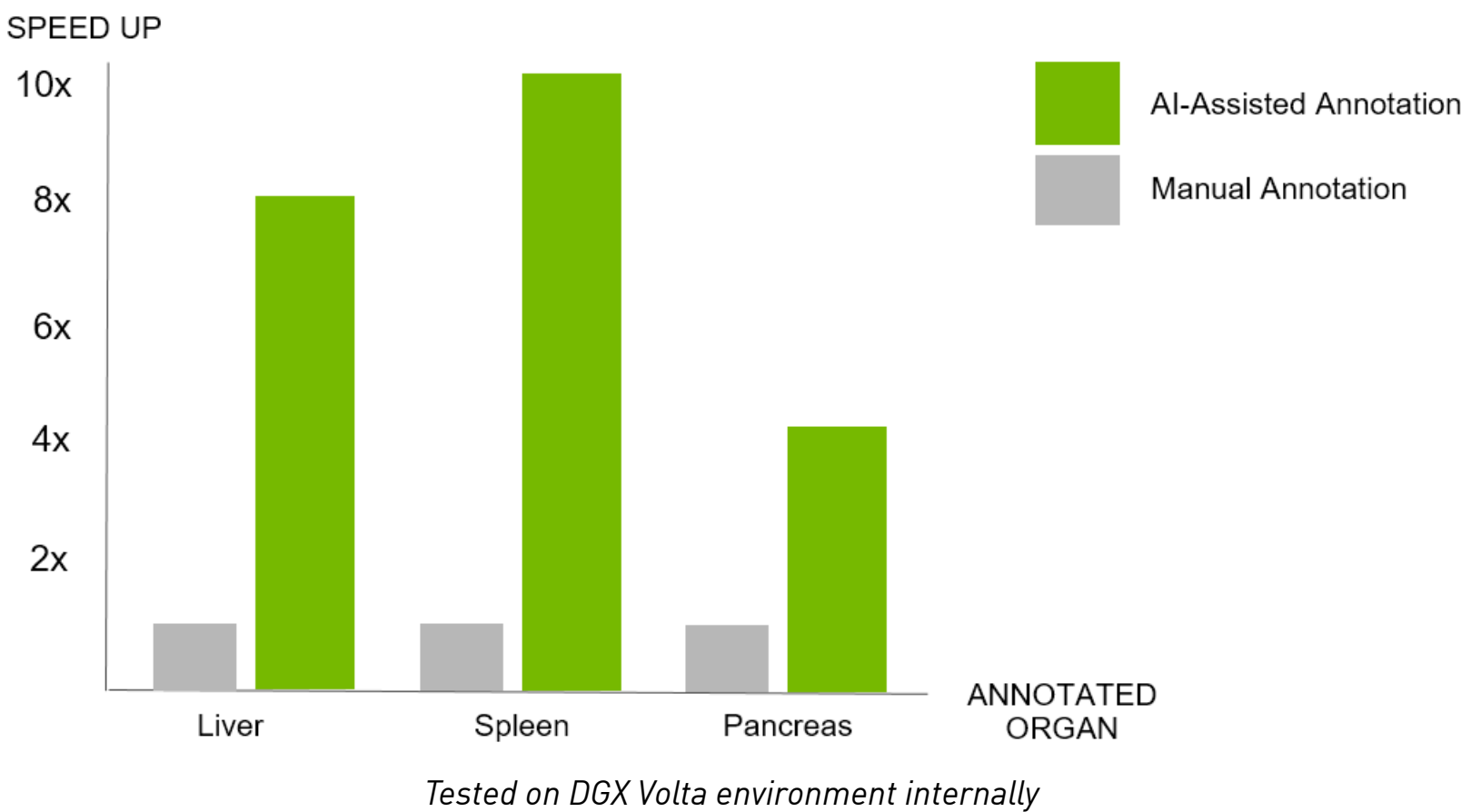
Download Clara Train SDK (<https://ngc.nvidia.com/catalog/containers/nvidia:clara-train-sdk>)

Documentation (<https://docs.nvidia.com/clara/>)

Annotation Client (<https://github.com/NVIDIA/ai-assisted-annotation-client>)

Devtalk Forum (<https://devtalk.nvidia.com/default/board/361/healthcare/>)

## AI-Assisted Annotation Speedup



"We were able to get our hands on NVIDIA's AI Assisted Annotation technology and integrate it into our viewer in a couple of days' time. We currently annotate a lot of images - sometimes on the order of 1000 or more a day, so any technology that can help automate this process could potentially have a significant impact in reducing the time and cost of annotation. We are excited to leverage the AI assisted workflows and work with NVIDIA to solve these critical medical imaging problems."

— Mark Michalski, Executive Director at MGH & BWH Center for Clinical Data Science

MGH & BWH CENTER FOR  
CLINICAL DATA SCIENCE

## Clara Deploy

**Clara Deploy SDK** provides a container based development & deployment framework for building AI accelerated medical imaging workflows, it uses Kubernetes under the hood and enables developers and data scientists to define a multi-staged container based pipeline. The modular architecture allows developers to use the offerings of the platform end-end or customize the workflow pipelines with bring-your-own algorithms.

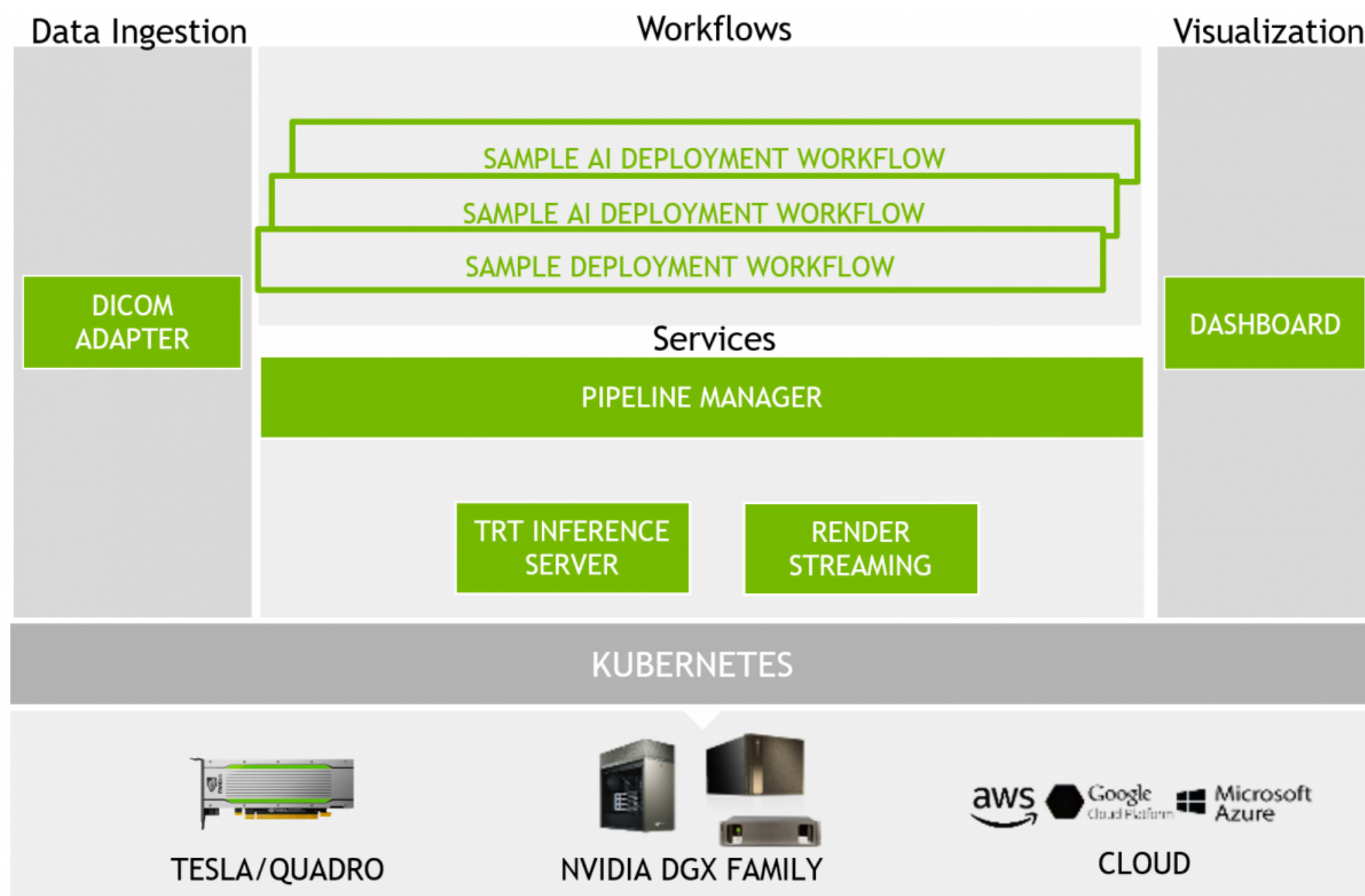
The capabilities forming the Clara Deploy SDK include:

- Data Ingestion interface to communicate to Hospital PACs system
- Cores services for orchestrating and managing resources for workflow deployment and development
- Reference AI applications that can be used as-is with user defined data or can be modified with user-defined-AI algorithms
- Lastly, Clara Deploy framework also includes Visualization capabilities to monitor progress and view final results

Documentation (<https://docs.nvidia.com/clara/deploy/index.html>)

NGC Download ([https://ngc.nvidia.com/catalog/model-scripts/nvidia:clara\\_deploy\\_sdk](https://ngc.nvidia.com/catalog/model-scripts/nvidia:clara_deploy_sdk))





## DEEP LEARNING LIBRARIES

The compute Foundation of Clara platform is based off CUDA acceleration and System Software libraries for compute and visualization that expose capabilities of GPUs through SDKs and low level APIs.

CUDNN ([/cudnn](#))

TensorRT ([/tensorrt](#))

TRTIS (<https://docs.nvidia.com/deeplearning/sdk/tensorrt-inference-server-guide/docs/>)

## AI ACCELERATION FOR SCAN AUTOMATION TO ANATOMY CLASSIFICATION

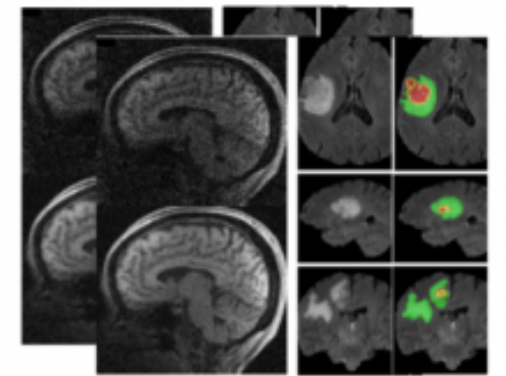
### Optimized DNN Primitives

- CuDNN includes highly tuned routines for DNNs
- Accelerates widely used deep learning frameworks
- TensorCores acceleration with FP32 models
- Upto 10x speedups for convolution calls



### Inference

- TensorRT High perf DL Inference library
- Deploy Weight Updates Faster.
- 8x Faster Inference than TensorFlow Only
- Deploy INT8 Precision on DLA Accelerator
- Integrated with Tensorflow 2.0 & ONNX Runtime



([/deep-learning-software](#))

## IMAGE & SIGNAL PROCESSING

Image and Signal Processing (<https://developer.nvidia.com/gpu-accelerated-libraries#linear-algebra>)

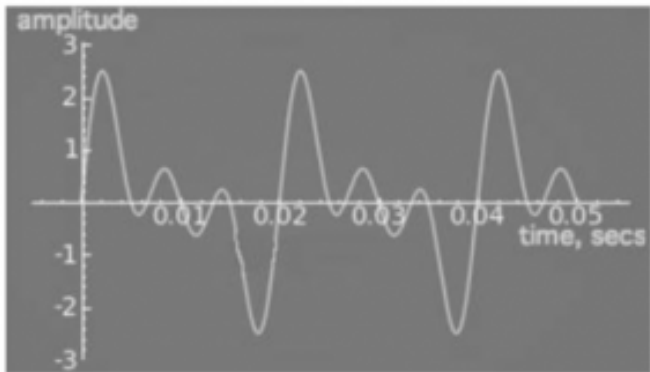
MATRIX MULTIPLICATION

- **cuBLASLt**: New dense matrix multiplication library
- Enhanced hardware support including Turing integer Tensorcore
- Full algorithm control
- **cuSPARSE**: Simplified, Flexible APIs.
- Enhanced Perf



FIXED FOURIER TRANSFORMS

- FFTs are memory bound
- **New Library: cuFFTDx Device Extension**
- Device callable library
- Retain and reuse on-chip data
- Inline FFTs in user kernel to facilitate fusion with other CUDA kernel
- Apply for EA - GA - mid-June 2019

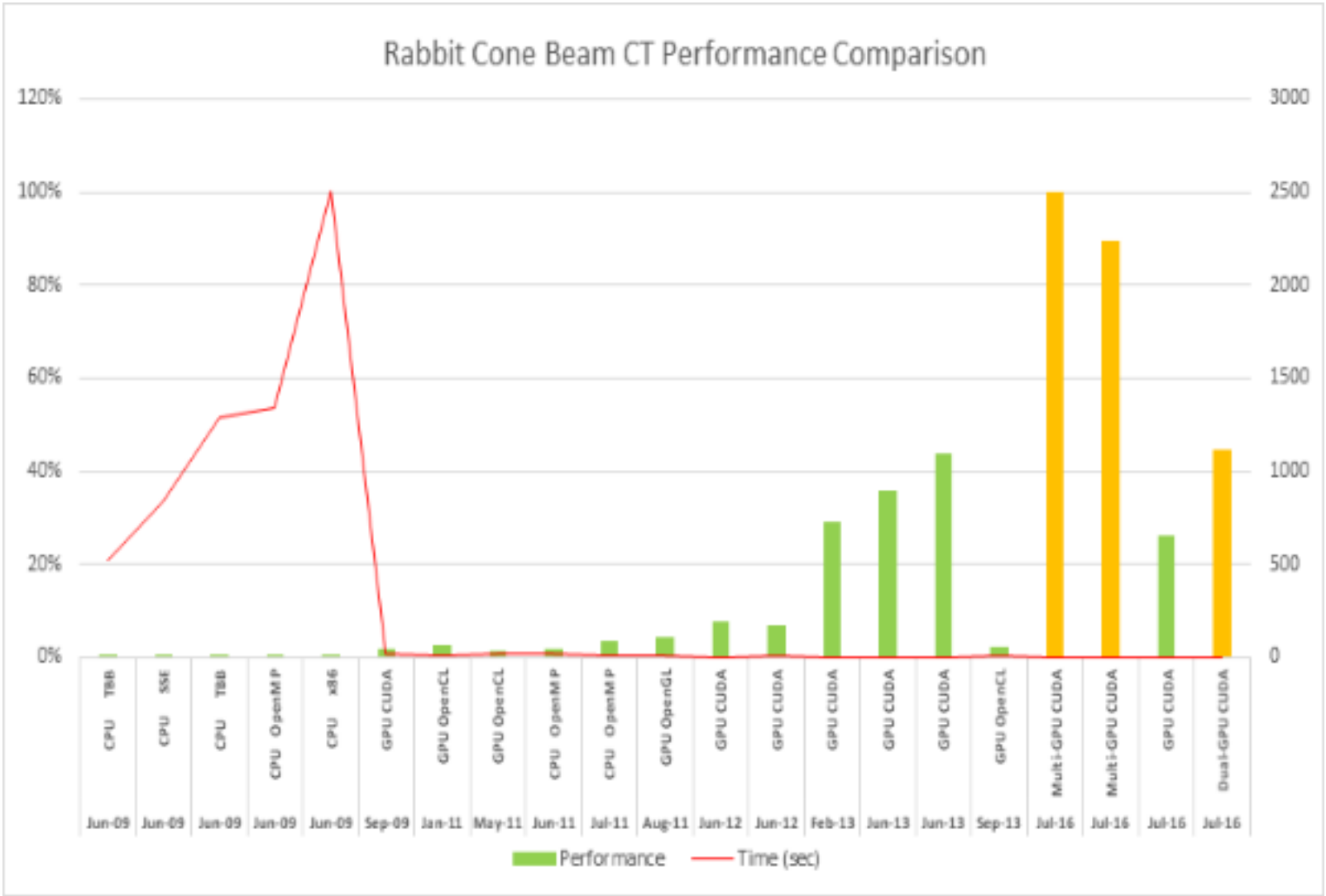


TENSORS EVERYWHERE

- **cuTENSOR** - High performance CUDA library for Tensor Primitive
- Tensor Contractions (generalization of matrix-matrix multiplication)
- Element-wise operations (e.g., permutations, additions)
- Pre-release version available



(<https://developer.nvidia.com/gpu-accelerated-libraries#linear-algebra>)



RabbitCT---an open platform for benchmarking 3D cone-beam reconstruction algorithms" Christopher Rohkohl, Benjamin Keck, Hannes G. Hofmann and Joachim Hornegger, Med. Phys. 36, 3940 (2009), DOI:10.1118/1.3180956 Download PDF (<http://www5.informatik.uni-erlangen.de/Forschung/Publikationen/2009/Rohkohl09-TNR.pdf>)  
- View BibTeX (<http://univis.uni-erlangen.de/prg?search=publications&id=90975790&show=bibtex>)

- More cone beam CT research being done using CUDA than any other accelerator technology
- CUDA outperforms other accelerated technologies by an order of magnitude or more
- Most recent algorithmic developments being done are all CUDA accelerated

Advanced Visualization

Download Latest Advanced Vizualization Libraries

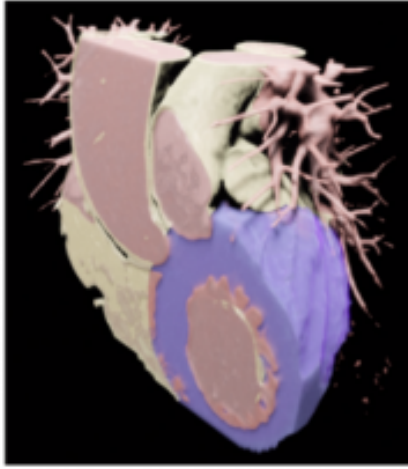
<a href="#">OptiX (/optix)</a>	<a href="#">Video Codec (/nvidia-video-codec-sdk)</a>	<a href="#">Deepstream SDK (/deepstream-sdk)</a>	<a href="#">Optical Flow (/opticalflow-sdk)</a>
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# HW ACCELERATED OPTICAL FLOW & REAL-TIME RAYTRACING

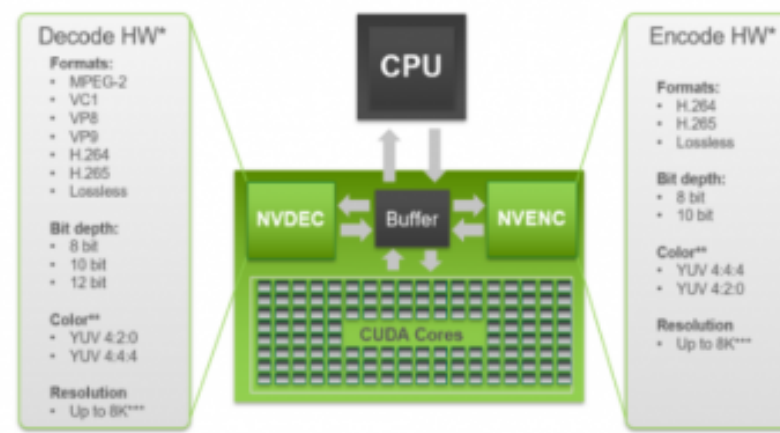
## VOLUMETRIC RENDERING

- RT Cores enabled Real-time raytracing - **OptiX 6.0**
- Clara Render Server out of box streaming renderer



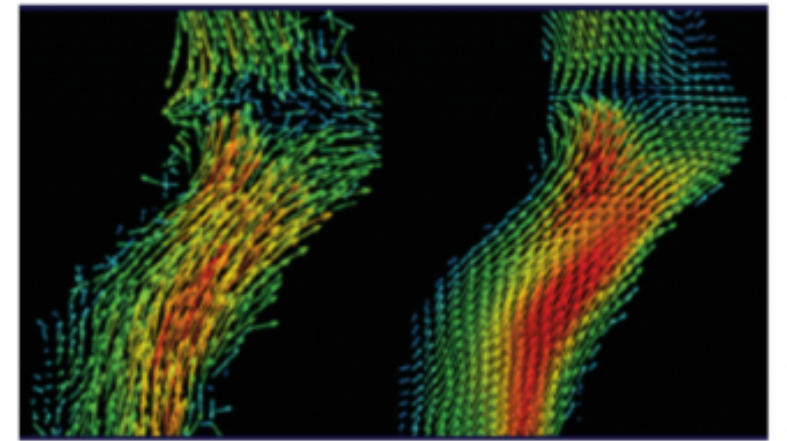
## HW ACCELERATED ENCODE/DECODER

- Upto 3x Decoder throughput with Turing based Tesla/Quadro - **Video Codec SDK 9.0**
- Rate Distortion & Image Quality improvements for encoder



## OPTICAL FLOW

- **Optical Flow SDK 1.0**: APIs for HW generated optical flow maps
- Granularity 4x4 vectors at 1/4 pixel resolution
- High Accuracy



(<https://developer.nvidia.com/designworks>)

## NVIDIA DEVELOPER PARTNERS

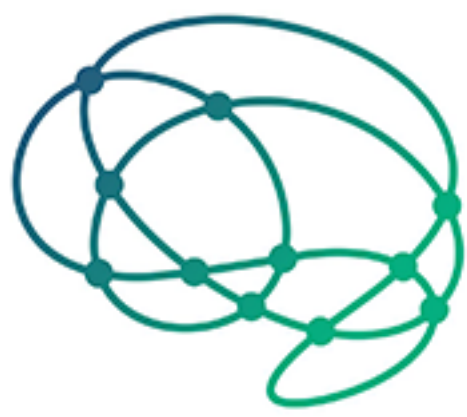


## Developer Showcase

We specialize in accelerated medical image computing and guided surgery. NVIDIA's Clara platform gives us the ability to turn 2D medical images into 3D and deploy our technology virtually.

— Wolfgang Wein, Founder and CEO





# SUBTLE MEDICAL

We are using AI to improve workflow for MRI and PET exams. NVIDIA's Clara platform will enable us to seamlessly scale our technology to reduce risks from contrast and radiation, taking imaging efficiency and safety to the next level.

— Enhao Gong, Founder

We would love to showcase your work developed on NVIDIA Clara Platform, send us a notification

[Here \(/clara-sw-notification\)](/clara-sw-notification)

## Get Started With Hands-On Training

The NVIDIA Deep Learning Institute (<https://www.nvidia.com/en-us/deep-learning-ai/education/?ncid=so-dis-dldlwsd1-72342>) (DLI) offers hands-on training for developers, data scientists, and researchers in AI and accelerated computing. Start your hands-on training in AI for Game Development with self-paced courses in Computer Vision (<https://courses.nvidia.com/courses/course-v1:DLI+C-FX-01+V2/about?ncid=so-dis-dldlwsd1-72346>), CUDA/C++ (<https://courses.nvidia.com/courses/course-v1:DLI+C-AC-01+V1/about?ncid=so-dis-dldlwsd1-72343>), and CUDA Python (<https://courses.nvidia.com/courses/course-v1:DLI+C-AC-02+V1/about?ncid=so-dis-dldlwsd1-72344>). Plus, check out two-hour electives on Deep Learning for Digital Content Creation and Game Development (<https://www.nvidia.com/en-us/deep-learning-ai/education/?ncid=so-dis-dldlwsd1-72528#dlti>).



# DEEP LEARNING INSTITUTE

(<https://www.nvidia.com/en-us/deep-learning-ai/education/?ncid=so-dis-dldlwsd1-72347>)

[HIGH PERFORMANCE COMPUTING \(/HPC\)](#)

[GAMEWORKS \(/GAMEWORKS\)](#)

[JETPACK \(/EMBEDDED-COMPUTING\)](#)

[DESIGNWORKS \(/DESIGNWORKS\)](#)

[DRIVE \(/DRIVE\)](#)

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