NVIDIA VIDEO CODEC SDK - DECODER

Application Note

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Chapter 1. NVIDIA Hardware Video Decoder

1.1. Introduction

NVIDIA GPUs contain a hardware-based decoder (referred to as NVDEC in this document) which provides fully accelerated hardware-based video decoding for several popular codecs. With complete decoding offloaded to NVDEC, the graphics engine and CPU are free for other operations.

NVDEC supports much faster than real-time decoding which makes it suitable for transcoding scenarios in addition to video playback.

The hardware capabilities available in NVDEC are exposed through APIs referred to as NVDECODE APIs in this document. This document provides information about the capabilities of the NVDEC engine and the features exposed through NVDECODE APIs. The current document highlights *only* the changes in the current video codec SDK package with respect to the previous SDK packages. To know about the features exposed in earlier SDKs please refer to the earlier SDK package(s).

1.2. NVDEC Capabilities

At a high level, Table 1 summarizes the capabilities of the NVDEC engine exposed through NVDECODE APIs.

Table 1. NVDEC Hardware Capabilities

Hardware Features	1st Gen Maxwell GPUs	2nd Gen Maxwell GPUs	Pascal GPUs	Volta GPUs	Turing/ GA100/ Hopper GPUs	GA10x[3] and Ada GPUs	Blackwell GPUs
VC1 Simple, Main & Advanced profiles	Y	Y	Y	Y	Y	Y	Y

Hardware Features	1st Gen Maxwell GPUs	2nd Gen Maxwell GPUs	Pascal GPUs	Volta GPUs	Turing/ GA100/ Hopper GPUs	GA10x[3] and Ada GPUs	Blackwell GPUs
MPEG4 Simple and Advanced Simple Profiles	Y	Y	Y	Y	Y	Y	Y
MPEG2 Simple & Main profiles	Y	Y	Y	Y	Y	Y	Y
H.264 Baseline, Main, High Profiles	Y	Y	Y	Y	Y	Y	Y
VP8	N	Y	Y[1]	Y	Y	Y	Y
HEVC Main and Main 10 Profile[1]	N	Y[1]	Y	Y	Y	Y	Y
VP9 Profile 0[1]	N	Y[1]	Y	Y	Y	Y	Y
8192x8192 Decoding support (HEVC&VP9 only)	N	N	Y[1]	Y	Y	Y	Y
Multiple NVDECs[2]	N	N	N	N	Y	Y	Y
HEVC 444 decoding	N	N	N	N	Y	Y	Y
AV1 Main Profile decoding	N	N	N	N	N	Y	Y
8192x8192 Decoding support (H264)	N	N	N	N	N	N	Y
H264 High10/ High422 profiles	N	N	N	N	N	N	Y
HEVC main 422 10/12 profiles	N	N	N	N	N	N	Y

- **Y**: Supported, **N**: Unsupported
- [1]: Present in select GPUs
- [2]: Present in select GPUs
- [3]: GA10x GPUs include all GPUs based on Ampere architecture except GA100

1.3. NVDEC Performance

NVDEC natively supports multiple hardware decoding contexts with negligible context-switching penalty. As a result, subject to the hardware performance limit and available memory, an application can decode multiple videos simultaneously.

The hardware and software maintain the context for each decoding session, allowing many simultaneous decoding sessions to run in parallel with minimal context switch penalty. Table 2 provides indicative data of the decoding performance of NVDEC in GPUs based on Maxwell, Pascal, Turing and Ampere architectures for AV1, HEVC, VP9, and H.264 encoded bitstreams.

The performance varies across GPU classes (e.g. Quadro, Tesla), and scales (almost) linearly with the clock speeds for each hardware.

Table 2. NVDEC decoding performance (indicative)

GPU Architecture	Codec	Performance in frames/second
Pascal	H.264	694
	VP9	846
	HEVC	810
	HEVC Main10	789
Turing	H.264	771
	VP9	932
	VP9 10 bit	925
	HEVC	1316
	HEVC Main10	1158
Ampere	H.264	748
	VP9	1075
	VP9 10 bit	1120
	HEVC	1415
	HEVC Main10	1299
	AV1	790
Ada	H.264	903
	VP9	1290
	VP9 10 bit	1342
	HEVC	1641
	HEVC Main10	1520
	AV1	1018
Blackwell	H.264	2172
	VP9	1445
	VP9 10 bit	1498
	HEVC	1872
	HEVC Main10	1818
	AV1	1119

- All the measurement is done on the highest video clocks as reported by nvidia-smi (i.e. 1544 MHz, 1860 MHz, 1665 MHz, 2160 MHz, 2362 MHz for Pascal, Turing, Ampere, Ada, and Blackwell respectively). The performance should scale according to the video clocks as reported by nvidia-smi on target GPU. Information on nvidia-smi can be found at https://developer.nvidia.com/nvidia-system-management-interface .
- Resolution/Input format: 1920x1080/YUV 4:2:0

- Software: Windows 11, Video Codec SDK v13.0
- Hopper and GA100 GPUs contain NVDEC with same architecture as Turing. As a result, the decoding performance on Hopper and GA100 GPUs is same as that of Turing GPUs, scaled by the clock speed. To view the clocks available on your GPU, please use the tool nvidia-smi included with the NVIDIA driver.

While Maxwell, Pascal, and Volta generation GPUs had one NVDEC engine per chip, some GPUs based on Turing, Ampere, Ada, Hopper and Blackwell architecture have multiple NVDEC engines per chip. GH100 and GB100 has 8 NVDECs. This increases the aggregate decoding throughput of the GPU. The NVIDIA driver takes care of load balancing among multiple NVDEC engines on the chip so that applications don't require special code to take advantage of multiple decoders, and automatically benefit from higher decoder capacity on higher-end GPU hardware. The decode performance listed in Table 2 is given per NVDEC engine. Thus, if a Quadro or Tesla GPU has 2 NVDECs, multiply the corresponding number in Table 2 by the number of NVDECs per chip to get aggregate maximum performance (applicable only when running multiple simultaneous decode sessions). Note that performance with a single decoding session cannot exceed performance per NVDEC, regardless of the number of NVDECs present on the GPU. All GeForce products consist of a single NVDEC.

1.4. Programming NVDEC

Refer to the SDK release notes for information regarding the required driver version.

Various capabilities of NVDEC are exposed to the application software via the NVIDIA proprietary application programming interface (NVDECODE APIs). Refer to the Video Decoder Programming guide for details on using these APIs.

For a complete list of GPUs supporting hardware accelerated decoding refer to https://developer.nvidia.com/nvidia-video-codec-sdk.

1.5. FFmpeg Support

FFmpeg is the most popular multimedia transcoding tool used extensively for video and audio transcoding.

The video hardware accelerators in NVIDIA GPUs can be effectively used with FFmpeg to significantly speed up the video decoding, encoding and end-to-end transcoding at very high performance.

Note that FFmpeg is open-source project and its usage is governed by specific licenses and terms and conditions.

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