Scalable Video Technology for HEVC Encoder (SVT-HEVC Encoder) User Guide

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1. Introduction

This document describes the system requirements and how to use the Scalable Video Technology for HEVC Encoder (SVT-HEVC). In particular, this user guide section describes how to run the sample application with the respective dynamically linked library.

2. System Requirements

The SVT-HEVC Encoder library was developed to be supported on x86 for Windows* and Linux* operating systems.

2.1 CPU requirements

In order to achieve the performance targeted by the deliverable, the specific CPU model listed in the Readme file would need to be used when running the encoder. Otherwise, the encoder should run on any 5th Generation Intel Core™ Processors (formerly Broadwell) CPUs (for example Xeon E5 v4) or newer, producing the same output.

2.2 RAM requirements

In order to run the highest resolution supported by the encoder, at least 64GB of RAM is required to run a single 8kp60 10-bit encode. The encoder application will display an error if the system does not have enough RAM to support this resolution. The table below lists the minimum amount of RAM required for some standard resolutions of 10bit video per channel:

Resolution	Minimum Footprint in GB
8k	64
4k	16
1080p	6
720p/1080i	4
480p	3

2.3 Operating systems

The list below includes the operating systems that the encoder application and library could run on, assuming the above pre-requisites are met.

Windows* Operating Systems (64-bit)

- Windows* 10
- Windows* Server 2016 Standard

Linux* Operating Systems (64-bit)

- Ubuntu* 16.04 Desktop LTS
- Ubuntu* 16.04 Server LTS
- Ubuntu* 18.04 Desktop LTS
- Ubuntu* 18.04 Server LTS

2.4 Build the code

The list below includes the build tools necessary for the encoder application and library to build properly.

Windows* Operating Systems (64-bit)

- Build requirements
    - Visual Studio* 2017
    - YASM Assembler version 1.2.0 or later
        - Download the yasm exe from the following link
        - Rename yasm-1.3.0-win64.exe to yasm.exe
        - Copy yasm.exe into a location that is in your system PATH environment variable
    - CMake 3.5 or later link
- Build instructions
    - Generate the Visual Studio* 2017 project files by following the steps below in a windows command line prompt:
        - In the main repository directory go under the <repo dir>\Build\windows location
        - Run generate_vs17.bat [such would generate the visual studio project files]
        - Open the "svt-hevc.sln" using Visual Studio* 2017 and click on Build -- > Build Solution
- Binaries Location
    - Binaries can be found under <repo dir>\Bin/Release or <repo dir>\Bin/Debug, depending on whether Debug or Release were selected in the build mode

Linux* Operating Systems (64-bit)

- Build requirements
    - GCC 5.4.0
    - CMake 3.5.1
    - YASM Assembler version 1.2.0 or later
- Build instructions
    - In the main repository, run
        - mkdir build && cd build && cmake .. && make -j `nproc` && sudo make install
- Binaries Location:
    - Binaries can be found under Bin/Release

2.5 Installation

For the binaries to operate properly on your system, the following conditions have to be met:

- Windows*:
    - On any of the Windows* operating systems listed in section 2.3, Install Visual Studio 2017
    - Once the installation is complete, copy the binaries to a location making sure that both the sample application “SvtHevcEncApp.exe” and library “SvtHevcEnc.dll” are in the same folder.
    - Open the command line at the chosen location and run the sample application to encode.
- Linux*:
    - On any of the Linux* operating systems listed in section 2.3, copy the binaries under a location of your choice.
    - Change the permissions on the sample application “SvtHevcEncApp” executable by running the command:
        - chmod +x SvtHevcEncApp
    - To enable 100% CPU utilization for the real-time SvtHevcEncApp, run the command:
        - sudo sysctl -w kernel.sched_rt_runtime_us=1000000
    - Open terminal and cd into your directory, then run the sample application to encode

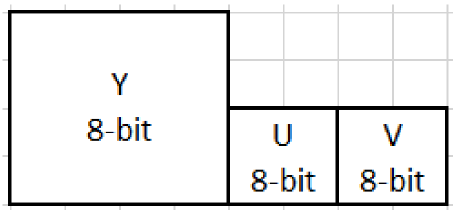
3 Sample Application Guide

This section describes how to run the sample encoder application that uses the SVT-HEVC Encoder library. It describes the input video format, the command line input parameters and the resulting outputs.

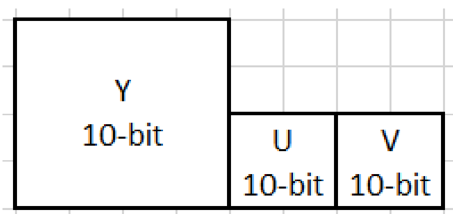
3.1 Input Video Format

The SVT-HEVC Encoder supports the following input formats:

- 8-bit yuv420p



- 10-bit yuv420p10le

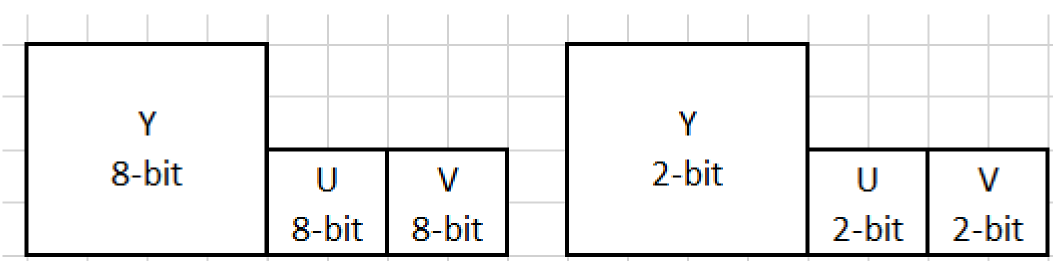


3.2 Compressed 10-bit format

In order to reduce the size of the input original YUV file, the SVT-HEVC Encoder uses a compressed 10-bit format allowing the software to achieve a higher speed and channel density levels. The conversion between the 10-bit yuv420p10le and the compressed 10-bit format is a lossless operation and is performed using the following steps.

3.2.1 Unpack the 10 bit picture

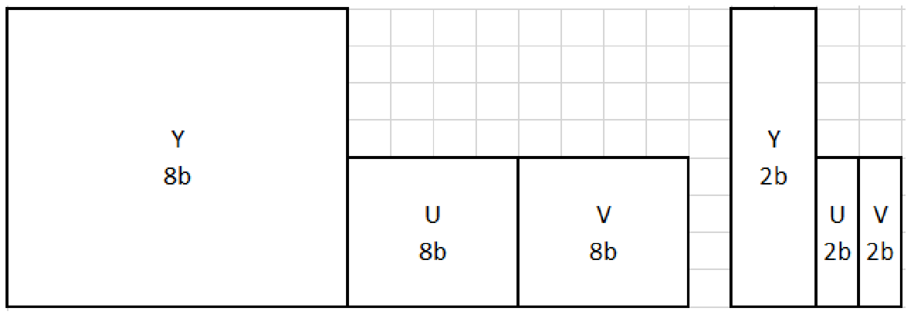
This step consists of separating the 10 bit video samples into 8 bit and 2 bit planes so that each 10-bit picture will be represented as two separate pictures as shown in the figure below. As a result of the operation, the 2 least significant bits of the 10 bits will be written into a full byte.



10-bit yuv420p10le unpacked

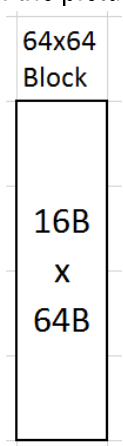
3.2.2 Compress the 2 bit Plane

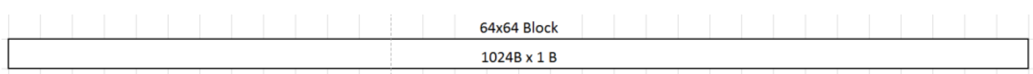
The unpacking steps separates the 10bits into a group of 8 bits and a group of 2 bits, where the 2 bits are stored in a byte. In this step, every group of consecutive 4 bytes, each containing 2bits from the unpacking step, are compressed into one byte. As a result, each 10bit picture will be represented as two separate pictures as shown in the figure below.



3.2.3 Unroll the 64x64

Now for a faster read of the samples, every 64x64 block of the 2 bit picture should be written into a one dimensional array. Therefore, the top left 64x64 sample block which is now written into a 16 bytes x 64 bytes after the compression of the 2bit samples, will be written into a 1024 bytes x 1 byte array as shown in the picture below.





64x64 block after unrolling

64x64 block after 2 bit compression.

3.3 Running the encoder

This section describes how to run the sample encoder application SvtHevcEncApp.exe (on Windows*) or SvtHevcEncApp (on Linux*) from the command line, including descriptions of the most commonly used input parameters and outputs.

The sample application typically takes the following command line parameters:

-c filename [**Optional**]

A text file that contains encoder parameters such as input file name, quantization parameter etc. Refer to the comments in the Config/Sample.cfg for specific details. The list of encoder parameters are also listed below. Note that command line parameters take precedence over the parameters included in the configuration file when there is a conflict.

-tune integer **[Optional]**
This token sets the encoder to run in either the subjective quality optimized mode (when set to 0) or in the objective quality optimized mode (when set to 1 [default setting])

-i filename **[Required]**
A YUV file (e.g. 8 bit 4:2:0 planar) containing the video sequence that will be encoded. The dimensions of each image are specified by –w and –h as indicated below.

-b filename **[Optional]**
The resulting encoded bit stream file in binary format. If none specified, no output bit stream will be produced by the encoder.

-w integer **[Required]**
The width of each input image in units of picture luma pixels, e.g. 1920

-h integer **[Required]**]
The height of each input image in units of picture luma pixels, e.g. 1080

-n integer **[Optional]**
The number of frames of the sequence to encode. e.g. 100. If the input frame count is larger than the number of frames in the input video, the encoder will loopback to the first frame when it's done.

-intra-period integer **[Optional]**
The intra period defines the interval of frames after which you insert an Intra refresh. It is strongly recommended to use (multiple of 8) -1 the closest to 1 second (e.g. 55, 47, 31, 23 should be used for 60, 50, 30, (24 or 25) respectively)

-rc integer **[Optional]**
This token sets the bitrate control encoding mode [1: Variable Bitrate, 0: Constant QP]. When rc is set to 1, it's best to match the –lad (lookahead distance described in the next section) parameter to the -intra-period. When –rc is set to 0, a qp value is expected with the use of the –q command line option otherwise a default value is assigned (25).

-speed-ctrl integer **[Optional]**
This token sets the encoder to automatically choose the best quality encoding mode that allows the encoder to run at a real-time speed set by the –fps parameter (described in the next section).

For example, the following command encodes 100 frames of the YUV video sequence into the bin bit stream file. The picture is 1920 luma pixels wide and 1080 pixels high using the Sample.cfg configuration. The QP equals 30 and the md5 checksum is not included in the bit stream.

> SvtHevcEncApp.exe -c Sample.cfg -i CrowdRun_1920x1080.yuv -w 1920 -h 1080 -n 100 -q 30 -intra-period 31 -b CrowdRun_1920x1080_qp30.bin

It should be noted that not all the encoder parameters present in the Sample.cfg can be changed using the command line.

3.3.1 List of all configuration parameters

The encoder parameters present in the Sample.cfg file are listed in this table below along with their status of support, command line parameter and the range of values that the parameters can take.

Encoder Parameter as shown in the configuration file	Command Line parameter	Range	Default	Description
	-nch	[1 - 6]	1	Number of encode instances
	-c	any string	null	Configuration file path
InputFile	-i	any string	null	Input file path and name
StreamFile	-b	any string	null	Output bitstream file path and name
ErrorFile	-errlog	any string	stderr	Error log displaying configuration or encode errors
ReconFile	-o	any string	null	Output reconstructed yuv used for debug purposes. **Note:** using this feature will affect the speed of the encoder significantly. This should only be used for debugging purposes.
UseQpFile	-use-q-file	[0,1]	0	When set to 1, overwrite the picture qp assignment using qp values in QpFile
QpFile	-qp-file	any string	null	Path to qp file
EncoderMode	-encMode	[0 - 12]	9	A preset defining the quality vs density tradeoff point that the encoding is to be performed at. (e.g. 0 is the highest quality mode, 12 is the highest density mode). Section 3.4 outlines the preset availability per resolution
Tune	-tune	[0,1]	1	0=SQ - subjective quality mode, 1=OQ - objective quality mode
LatencyMode	-latency-mode	[0,1]	0	For lower latency (0: Normal Latency, 1: Low Latency)
EncoderBitDepth	-bit-depth	[8 , 10]	8	specifies the bit depth of the input video

Encoder Parameter as shown in the configuration file	Command Line parameter	Range	Default	Description
CompressedTenBitFormat	-compressed-ten-bit-format	[0,1]	0	Offline packing of the 2bits: requires two bits packed input (0: OFF, 1: ON)
SourceWidth	-w	[64 - 8192]	0	Input source width
SourceHeight	-h	[64 - 4320]	0	Input source height
FrameToBeEncoded	-n	[0 - 2^31 - 1]	0	Number of frames to be encoded, if number of frames is > number of frames in file, the encoder will loop to the beginning and continue the encode. 0 encodes the full clip.
BufferedInput	-nb	[-1, 1 to 2^31 -1]	-1	number of frames to preload to the RAM before the start of the encode If -nb = 100 and –n 1000 -- > the encoder will encode the first 100 frames of the video 10 times Use -1 to not preload any frames.
Profile	-profile	[1,2]	2	1: Main, 2: Main 10
Tier	-tier	[0,1]	0	0: Main, 1: High
Level	-level	[1, 2, 2.1,3, 3.1, 4, 4.1, 5, 5.1, 5.2, 6, 6.1, 6.2]	0	0 to 6.2 [0 for auto determine Level]
FrameRate	-fps	[0 - 2^64 - 1]	25	If the number is less than 1000, the input frame rate is an integer number between 1 and 60, else the input number is in Q16 format (shifted by 16 bits) [Max allowed is 240 fps]. If FrameRateNumerator and FrameRateDenominator are both !=0 the encoder will ignore this parameter
FrameRateNumerator	-fps-num	[0 - 2^64 - 1]	0	Frame rate numerator e.g. 6000 When zero, the encoder will use –fps if FrameRateDenominator is also zero, otherwise an error is returned
FrameRateDenominator	-fps-denom	[0 - 2^64 - 1]	0	Frame rate denominator e.g. 100 When zero, the encoder will use –fps if FrameRateNumerator is also zero, otherwise an error is returned
Injector	-inj	[0,1]	0	Enable injection of input frames at the specified framerate (0: OFF, 1: ON)

Encoder Parameter as shown in the configuration file	Command Line parameter	Range	Default	Description
InjectorFrameRate	-inj-frm-rt	[1 - 240]	60	Frame Rate used for the injector. Recommended to match the encoder speed.
SpeedControlFlag	-speed-ctrl	[0,1]	0	Enables the Speed Control functionality to achieve the real-time encoding speed defined by –fps. When this parameter is set to 1 it forces –inj to be 1 -inj-frm-rt to be set to the –fps.
InterlacedVideo	-interlaced-video	[0,1]	0	1 : encoder will signal interlaced signal in the stream, 0 : assumes progressive signal
SeparateFields	-separate-fields	[0,1]	0	1 : Interlaced input, application will separate top and bottom fields and encode it as progressive 0 : Treat video as progressive video
HierarchicalLevels	-hierarchical-levels	[0 – 3]	3	0 : Flat 1: 2-Level Hierarchy 2: 3-Level Hierarchy 3: 4-Level Hierarchy Minigop Size = (2^HierarchicalLevels) (e.g. 3 == > 7B pyramid, 2 == > 3B Pyramid) Refer to Appendix A.1
BaseLayerSwitchMode	-base-layer-switch-mode	[0,1]	0	0 : Use B-frames in the base layer pointing to the same past picture 1 : Use P-frames in the base layer Refer to Appendix A.1
PredStructure	-pred-struct	[0 – 2]	2	0: Low Delay P 1: Low Delay B 2: Random Access Refer to Appendix A.1
IntraPeriod	-intra-period	[-2 - 255]	-2	Distance Between Intra Frame inserted. -1 denotes no intra update. -2 denotes auto.
IntraRefreshType	-irefresh-type	[1,2]	1	1: CRA (Open GOP) 2: IDR (Closed GOP)
QP	-q	[0 - 51]	25	Initial quantization parameter for the Intra pictures used when RateControlMode 0 (CQP)
LoopFilterDisable	-dlf	[0,1]	0	When set to 1 disables the Deblocking Loop Filtering
SAO	-sao	[0,1]	1	When set to 0 the encoder will not use the Sample Adaptive Filter

Encoder Parameter as shown in the configuration file	Command Line parameter	Range	Default	Description
UseDefaultMeHme	-use-default-me-hme	[0,1]	1	0 : Overwrite Default ME HME parameters 1 : Use default ME HME parameters, dependent on width and height
HME	-hme	[0,1]	1	Enable HME, 0 = OFF, 1 = ON
SearchAreaWidth	-search-w	[1 - 256]	Depends on input resolution	Search Area in Width
SearchAreaHeight	-search-h	[1 - 256]	Depends on input resolution	Search Area in Height
ConstrainedIntra	-constrd-intra	[0,1]	0	Allow the use of Constrained Intra, when enabled, this features yields to sending two PPSs in the HEVC Elementary streams 0 = OFF, 1 = ON
RateControlMode	-rc	[0,1]	0	0 : CQP , 1 : VBR
TargetBitRate	-tbr	Any Number	7000000	Target bitrate in bits / second. Only used when RateControlMode is set to 1
MaxQpAllowed	-max-qp	[0 - 51]	48	Maximum QP value allowed for rate control use. Only used when RateControlMode is set to 1. Has to be > = MinQpAllowed
MinQpAllowed	-min-qp	[0 - 50]	10	Minimum QP value allowed for rate control use. Only used when RateControlMode is set to 1. Has to be < MaxQpAllowed
LookAheadDistance	-lad	[0 - 250]	Depending on BRC mode	When RateControlMode is set to 1 it's best to set this parameter to be equal to the Intra period value (such is the default set by the encoder), When CQP is chosen, then a (2 * minigopsize +1) look ahead is recommended.
SceneChangeDetection	-scd	[0,1]	1	Enables or disables the scene change detection algorithm 0 = OFF, 1 = ON
BitRateReduction	-brr	[0,1]	1	Enables subjective quality algorithms to reduce the output bitrate with minimal or no subjective visual quality impact. (no support for –tune 1) 0 = OFF, 1 = ON

Encoder Parameter as shown in the configuration file	Command Line parameter	Range	Default	Description
ImproveSharpness	-sharp	[0,1]	1	This is a visual quality knob that allows the use of adaptive quantization within the picture and enables visual quality algorithms that improve the sharpness of the background. This feature is only available for 4k and 8k resolutions (no support for –tune 1) 0 = OFF, 1 = ON
VideoUsabilityInfo	-vid-info	[0,1]	0	Enables or disables sending a vui structure in the HEVC Elementary bitstream. 0 = OFF, 1 = ON
HighDynamicRangeInput	-hdr	[0,1]	0	When set to 1, signals HDR10 input in the output HEVC elementary bitstream and forces VideoUsabilityInfo to 1. 0 = OFF, 1 = ON
AccessUnitDelimiter	`-ua-delm`	[0,1]	0	SEI message, 0 = OFF, 1 = ON
BufferingPeriod	`-pbuff`	[0,1]	0	SEI message, 0 = OFF, 1 = ON
PictureTiming	`-tpic`	[0,1]	0	SEI message, 0 = OFF, 1 = ON. If 1, VideoUsabilityInfo should be also set to 1.
RegisteredUserData	`-reg-user-data`	[0,1]	0	SEI message, 0 = OFF, 1 = ON
UnregisteredUserData	`-unreg-user-data`	[0,1]	0	SEI message, 0 = OFF, 1 = ON
RecoveryPoint	`-recovery-point`	[0,1]	0	SEI message, 0 = OFF, 1 = ON
TemporalId	`-temporal-id`	[0,1]	1	0 = OFF, 1 = Insert temporal ID in NAL units
AsmType	`-asm`	[0,1]	1	Assembly instruction set (0: C Only, 1: Automatically select highest assembly instruction set supported)
LogicalProcessorNumber	-lp	[0, total number of logical processor]	0	The number of logical processor which encoder threads run on. Refer to Appendix A.2
TargetSocket	-ss	[-1,1]	-1	For dual socket systems, this can specify which socket the encoder runs on. Refer to Appendix A.2

Encoder Parameter as shown in the configuration file	Command Line parameter	Range	Default	Description
SwitchThreadsToRtPriority	-rt	[0,1]	1	Enables or disables threads to real time priority, 0 = OFF, 1 = ON (only works on Linux)
FPSInVPS	-fpsinvps	[0,1]	0	Enables or disables the VPS timing info, 0 = OFF, 1 = ON

3.4 Encoding presets table

The table below shows the preset availability per encoding mode and resolution.

Preset (-encMode)	Subjective Quality Mode [SQ] (-tune 0)					Objective Quality Mode [OQ] (-tune 1)				
	480p Resolution Class	720p Resolution Class	1080p Resolution Class	4k Resolution Class	8k Resolution Class	480p Resolution Class	720p Resolution Class	1080p Resolution Class	4k Resolution Class	8k Resolution Class
0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
9	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10	x	x	✓	✓	✓	x	x	✓	✓	✓
11	x	x	x	✓	✓	x	x	x	x	x
12	x	x	x	✓	✓	x	x	x	x	x

4 Best Known Configurations (BKC)

This section outlines the best known hardware and software configurations that would allow the SVT-HEVC Encoder to run with the highest computational performance. For the CQP mode, the output bit stream will not change if these BKCs have not been applied.

4.1 Hardware BKC

The SVT-HEVC Encoder is optimized for use on Xeon® Scalable Processors products. For best multichannel encode, servers should be set up with at least one 2666 Mhz DDR4 RAM DIMM per RAM channel per socket. For example, a dual Xeon Platinum 8180 server is best set up with 12 x 2666 Mhz DDR4 RAM DIMM.

4.2 Software BKC

10 bit Input YUV

Due to the large size of 10-bit video, using the compressed YUV format as shown in section 3.2 allows for the best performance of the encoder.

Windows* OS (Tested on Windows* Server 2016)

Visual Studio 2017 offers Profile Guided Optimization (PGO) to improve compiler optimization for the application. The tool uses an instrumented build to generate a set of profile information of the most frequently used code and optimal paths. The profile is then used to provide extra information for the compiler to optimize the application. To take advantage of PGO, build using the following:

1. Open the solution file with Visual Studio 2017 and build code in Release mode
2. Right click SvtHevcEncApp project from the Solution Explorer -> Profile Guided Optimization -> Instrument (Repeat for SvtHevcEnc)
3. Right click SvtHevcEncApp project from the Solution Explorer -> Properties -> Debugging
4. Add configuration parameters and run encoder (e.g. 1280x720 video encode of 300 frames)
5. Right click SvtHevcEncApp project from the Solution Explorer -> Profile Guided Optimization -> Run Instrumented/Optimized Application
6. Right click SvtHevcEncApp project from the Solution Explorer -> Profile Guided Optimization -> Optimize (Repeat for SvtHevcEnc)

Linux* OS (Tested on Ubuntu* Server 18.04 and 16.04)

Some Linux* Operating systems and kernels assign CPU utilization limits to applications running on servers. Therefore, to allow the application to utilize up to ~100% of the CPUs assigned to it, it is best to run the following commands before and when running the encoder:

- sudo sysctl -w kernel.sched_rt_runtime_us=1000000
    - this command should be executed every time the server is rebooted

The above section is not needed for Windows* as it does not perform the CPU utilization limitation on the application.

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

Command line BKC

The SVT-HEVC encoder achieves the best performance when restricting each channel to only one socket on either Windows* or Linux* operating systems. For example, when running four channels on a dual socket system, it's best to pin two channels to each socket and not split every channel on both sockets.

LogicalProcessorNumber (-lp) and TargetSocket (-ss) parameters can be used to management the threads. Or you can use OS commands like below.

For example, in order to run a 6-stream 4kp60 simultaneous encode on a Xeon Platinum 8180 system the following command lines should be used:

Running Windows* Server 2016:

start /node 0 SvtHevcEncApp.exe -encMode 12 -tune 0 -w 3840 -h 2160 -bit-depth 10 -compressed-ten-bit-format 1 -i in.yuv -rc 1 –tbr 10000000 -fps 60 -b out1.bin -n 5000 –nb 500

start /node 0 SvtHevcEncApp.exe -encMode 12 -tune 0 -w 3840 -h 2160 -bit-depth 10 -compressed-ten-bit-format 1 -i in.yuv -rc 1 –tbr 10000000 -fps 60 -b out2.bin -n 5000 –nb 500

start /node 0 SvtHevcEncApp.exe -encMode 12 -tune 0 -w 3840 -h 2160 -bit-depth 10 -compressed-ten-bit-format 1 -i in.yuv -rc 1 –tbr 10000000 -fps 60 -b out3.bin -n 5000 –nb 500

start /node 1 SvtHevcEncApp.exe -encMode 12 -tune 0 -w 3840 -h 2160 -bit-depth 10 -compressed-ten-bit-format 1 -i in.yuv -rc 1 –tbr 10000000 -fps 60 -b out3.bin -n 5000 –nb 500

start /node 1 SvtHevcEncApp.exe -encMode 12 -tune 0 -w 3840 -h 2160 -bit-depth 10 -compressed-ten-bit-format 1 -i in.yuv -rc 1 –tbr 10000000 -fps 60 -b out4.bin -n 5000 –nb 500

start /node 1 SvtHevcEncApp.exe -encMode 12 -tune 0 -w 3840 -h 2160 -bit-depth 10 -compressed-ten-bit-format 1 -i in.yuv -rc 1 –tbr 10000000 -fps 60 -b out5.bin -n 5000 –nb 500

Running Ubuntu* 18.04:

taskset 0x0000000FFFFFFF0000000FFFFFFF ./ SvtHevcEncApp -encMode 12 -tune 0 -w 3840 -h 2160 -bit-depth 10 -compressed-ten-bit-format 1 -i in.yuv -rc 1 –tbr 10000000 -fps 60 -b out1.bin -n 5000 –nb 500 &

taskset 0x0000000FFFFFFF0000000FFFFFFF ./ SvtHevcEncApp -encMode 12 -tune 0 -w 3840 -h 2160 -bit-depth 10 -compressed-ten-bit-format 1 -i in.yuv -rc 1 –tbr 10000000 -fps 60 -b out2.bin -n 5000 –nb 500 &

taskset 0x0000000FFFFFFF0000000FFFFFFF ./ SvtHevcEncApp -encMode 12 -tune 0 -w 3840 -h 2160 -bit-depth 10 -compressed-ten-bit-format 1 -i in.yuv -rc 1 –tbr 10000000 -fps 60 -b out3.bin -n 5000 –nb 500 &

taskset 0xFFFFFFF0000000FFFFFFF0000000 ./ SvtHevcEncApp -encMode 12 -tune 0 -w 3840 -h 2160 -bit-depth 10 -compressed-ten-bit-format 1 -i in.yuv -rc 1 –tbr 10000000 -fps 60 -b out3.bin -n 5000 –nb 500 &

taskset 0xFFFFFFF0000000FFFFFFF0000000./ SvtHevcEncApp -encMode 12 -tune 0 -w 3840 -h 2160 -bit-depth 10 -compressed-ten-bit-format 1 -i in.yuv -rc 1 –tbr 10000000 -fps 60 -b out4.bin -n 5000 –nb 500 &

taskset 0xFFFFFFF0000000FFFFFFF0000000./ SvtHevcEncApp -encMode 12 -tune 0 -w 3840 -h 2160 -bit-depth 10 -compressed-ten-bit-format 1 -i in.yuv -rc 1 –tbr 10000000 -fps 60 -b out5.bin -n 5000 –nb 500 &

Similarly, in order to run a 2-stream 8kp50 simultaneous encode on a Xeon Platinum 8180 system the following command lines should be used:

Running Windows* Server 2016:

start /node 0 SvtHevcEncApp.exe -encMode 12 -tune 0 -w 7680 -h 4320 -bit-depth 10 -compressed-ten-bit-format 1 -i in.yuv -rc 1 –tbr 20000000 -fps 50 -b out1.bin -n 5000 –nb 500

start /node 1 SvtHevcEncApp.exe -encMode 12 -tune 0 -w 7680 -h 4320 -bit-depth 10 -compressed-ten-bit-format 1 -i in.yuv -rc 1 –tbr 20000000 -fps 50 -b out1.bin -n 5000 –nb 500

Running Ubuntu 18.04*:

taskset 0x0000000FFFFFFF0000000FFFFFFF ./ SvtHevcEncApp -encMode 12 -tune 0 -w 7680 -h 4320 -bit-depth 10 -compressed-ten-bit-format 1 -i in.yuv -rc 1 –tbr 20000000 -fps 50 -b out1.bin -n 5000 –nb 500 &

taskset 0xFFFFFFF0000000FFFFFFF0000000./ SvtHevcEncApp -encMode 12 -tune 0 -w 7680 -h 4320 -bit-depth 10 -compressed-ten-bit-format 1 -i in.yuv -rc 1 –tbr 20000000 -fps 50 -b out1.bin -n 5000 –nb 500 &

Where 0x0000000FFFFFFF0000000FFFFFFF and 0xFFFFFFF0000000FFFFFFF0000000 are masks for sockets 0 and 1 respectively on a dual 8180 system.

Appendix A. Encoder Parameters

A.1 Hierarchical coding structure parameters

The GOP is constructed assuming a prediction structure (PredStructure: LowDelay/Random-Access) and hierarchical levels (HierarchicalLevels: number of hierarchical layers).

The prediction structure (PredStructure) in SVT-HEVC encoder supports two main structures which are:

- Low Delay (P or B): In a LowDelay structure, pictures within a mini-GOP refer to the previously encoded pictures in display order. In other words, pictures with display order N can only be referenced by pictures with display order greater than N, and it can only refer pictures with picture order lower than N. The LowDelay prediction structure can be flat structured (e.g. IPPPPPPP....) or hierarchically structured as described in Figure A where a 3-Layer Hierarchical-LowDelay-P Structure is shown.

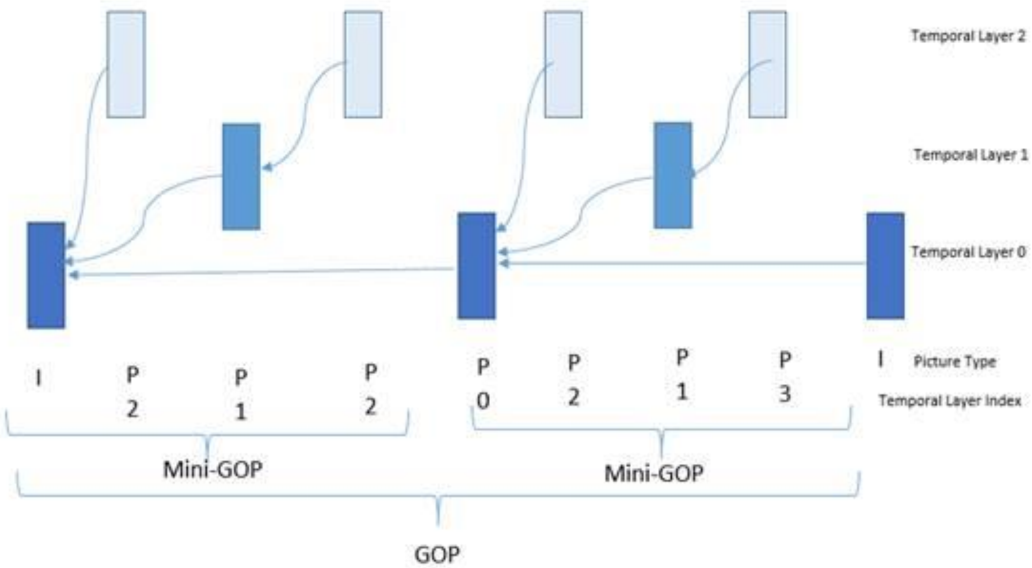


Figure A: Three-Layer Hierarchical-LowDelay Structure
("P" is a referenced picture and "p" is a non-referenced picture)

In a LowDelay structure, B/b pictures can be used instead of P/p pictures. However, the reference picture list 0 and the reference picture list 1 will contain the same reference picture as described in Figure B.

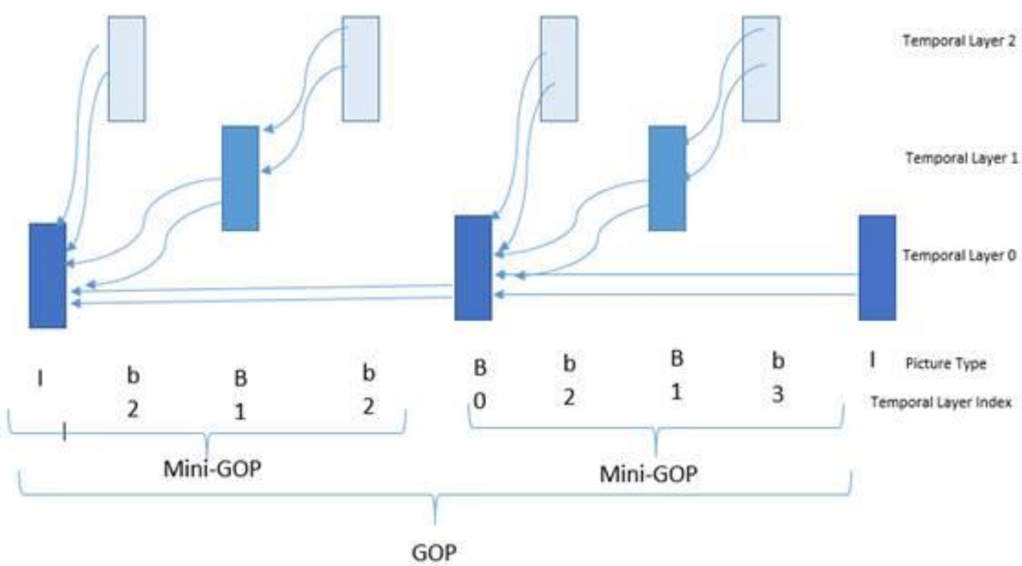


Figure B: Three-Layer Hierarchical-LowDelay Structure
("B" is a referenced picture and "b" is a non-referenced picture)

- Random Access: In this prediction structure, the B/b pictures can refer to reference pictures from both directions (past and future). Figure C shows an example of a three-layer random access prediction structure. In this figure, the B picture at temporal layer 0 can be replaced with a P picture and this is can be done through the configuration parameter "BaseLayerSwitchMode" by setting it to "1".

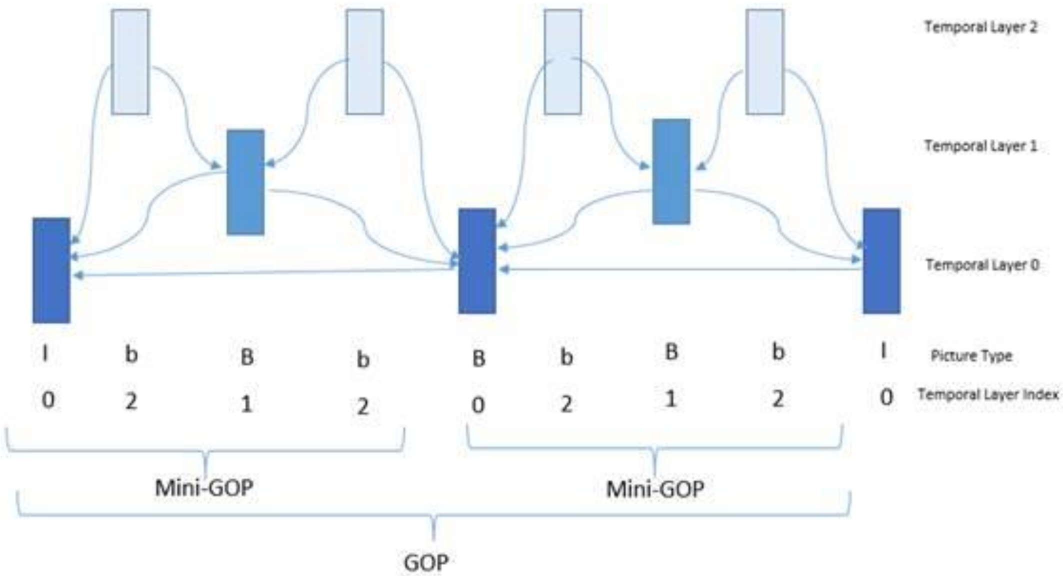


Figure C: Three-Layer Hierarchical-Random-Access Structure
("B" is a referenced picture and "b" is a non-referenced picture)

In the SVT-HEVC code, the GOP structure is constructed in the Picture Decision process which performs multi-picture level decisions, including setting the prediction structure, setting the picture type, and scene change detection. Since the prior Picture Analysis processes stage is multithreaded, inputs to the Picture Decision Process can arrive out-of-display-order, so a reordering queue is used to enforce processing of pictures in display order. The algorithms employed in the Picture Decision process are dependent on prior pictures' statistics, so the order in which pictures are processed must be strictly enforced. Additionally, the Picture Decision process uses the reorder queue to hold input pictures until they are ready to be sent to the Motion Analysis process, following the proper prediction structure.

A.2 Thread management parameters

LogicalProcessorNumber (-lp) and TargetSocket (-ss) parameters are used to management thread affinity on Windows and Ubuntu OS. These are some examples how you use them together.

If LogicalProcessorNumber and TargetSocket are not set, threads are managed by OS thread scheduler.

SvtHevcEncApp.exe -i in.yuv -w 3840 -h 2160 –lp 40
If only LogicalProcessorNumber is set, threads run on 40 logical processors. Threads may run on dual sockets if 40 is larger than logical processor number of a socket.
NOTE: On Windows, thread affinity can be set only by group on system with more than 64 logical processors. So, if 40 is larger than logical processor number of a single socket, threads run on all logical processors of both sockets.

SvtHevcEncApp.exe -i in.yuv -w 3840 -h 2160 –ss 1
If only TargetSocket is set, threads run on all the logical processors of socket 1.

SvtHevcEncApp.exe -i in.yuv -w 3840 -h 2160 –lp 20 –ss 0
If both LogicalProcessorNumber and TargetSocket are set, threads run on 20 logical processors of socket 0. Threads guaranteed to run only on socket 0 if 20 is larger than logical processor number of socket 0.

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