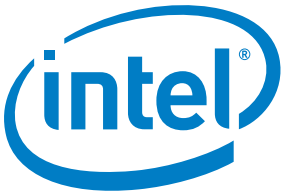


Concurrent Video Analytic Sample Application User Guide

Version 2020.3.0

Oct 2020

Contents

Revision History

Date	Revision	Description
2020/09/23	3.0	1. Update the OpenVINO and Media SDK version 2. Add descriptions for R3 new features
2020/05/19	2.0	1. Update the OpenVINO and Media SDK version 2. Add descriptions for R2 new features
2020/03/03	1.0	1. Add new example par files 2. Add tables to explain parameters usage in par file
2019/12/26	0.5	Initial release

Note: Releases in the table are listed in reverse order so that the latest/newest is in the top row.

§

1.0 Installation Guide

1.1 System installation

Install Ubuntu 18.04.04 to a Coffee Lake device (e.g. NUC8i7BEH)

Set up the network correctly and run “sudo apt update”

1.2 TGL-U Upgrade Linux kernel and iGPU firmware

You can skip this chapter if you’re using Sky Lake, Coffee Lake or Whiskey Lake U with GPU GEN 9.

To find out the GPU generation number, please run below command with root permission.

```
$cat /sys/kernel/debug/dri/0/i915_capabilities  | grep gen

gen: 9
```

On Tiger Like U, the GPU generation is 12.

1.2.1 Tiger Lake U: Upgrade Linux Kernel

Note, please back up your private files before upgrading Linux kernel.

Firstly, check if the Linux kernel has been upgraded to 5.4 or above:

```
$uname -a
```

If not, please use below command to upgrade to kernel 5.4 and reboot the device.

```
$sudo apt-get install --install-recommends linux-generic-hwe-18.04 xserver-xorg-hwe-18.04
```

Then run below commands to download and install Yocto Linux kernel for TGL

```
$ wget https://github.com/intel/linux-intel-lts/archive/refs/tags/lts-v5.4.102-yocto-

210310T010318Z.tar.gz

$ tar -xzf  lts-v5.4.102-yocto-210310T010318Z.tar.gz

$ cd lts-v5.4.102-yocto-210310T010318Z

$ cp /boot/config-5.4.0-51-generic  .config   //Copy Ubuntu default kernel config file
```

```
$ make oldconfig //Select the default value for unset config items

$ make -j8

$ sudo make INSTALL_MOD_STRIP=1 modules_install

$ sudo make install
```

Then edit the Linux kernel boot option and add “i915.force_probe=* i915.enable_guc=2” to force GPU module probe

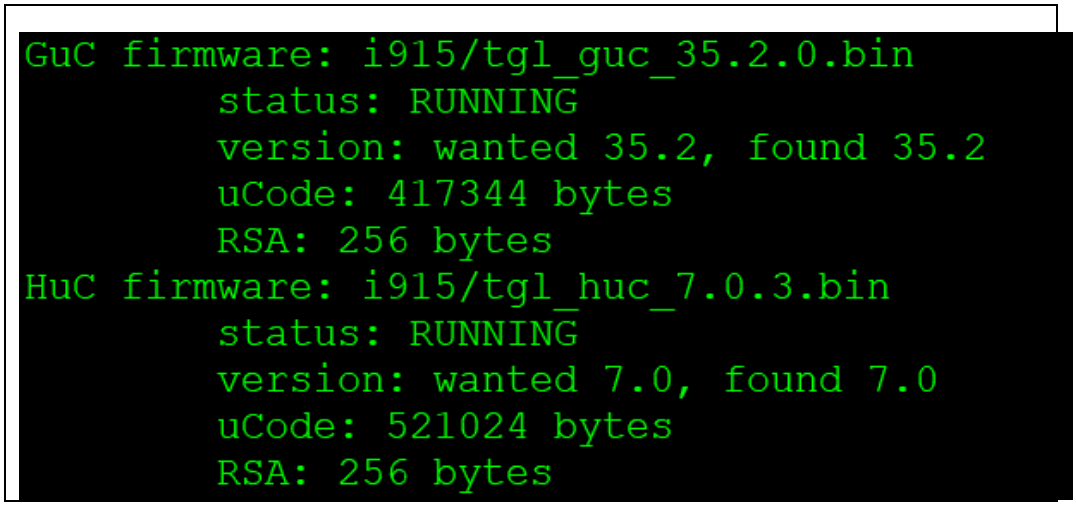
```
$ vi /etc/default/grub

# If you change this file, run 'update-grub' afterwards to update
# /boot/grub/grub.cfg.
# For full documentation of the options in this file, see:
#   info -f grub -n 'Simple configuration'

GRUB_DEFAULT="1> 2"
GRUB_TIMEOUT_STYLE=hidden
GRUB_TIMEOUT=0
GRUB_DISTRIBUTOR=`lsb_release -i -s 2> /dev/null || echo Debian`
GRUB_CMDLINE_LINUX_DEFAULT="quiet splash i915.force_probe=* i915.enable_guc=2"
GRUB_CMDLINE_LINUX=""

$ update-grub

Please check /boot/grub/grub.cfg to make sure above modification effective.
```

Please install GPU firmware by below command:

```
$ wget https://git.kernel.org/pub/scm/linux/kernel/git/firmware/linux-firmware.git/plain/i915/tgl_guc_35.2.0.bin

$ wget https://git.kernel.org/pub/scm/linux/kernel/git/firmware/linux-firmware.git/plain/i915/tgl_huc_7.0.12.bin

$ wget https://git.kernel.org/pub/scm/linux/kernel/git/firmware/linux-firmware.git/plain/i915/tgl_dmc_ver2_04.bin

$ cp *.bin /lib/firmware/i915

$ sudo update-initramfs

$ sync
```

After rebooting, please use below command to confirm the kernel upgrade and GPU firmware. The Firmware version requirement may be different due to the different kernel version. This snapshot comes from an older kernel version:

```
$uname -a // Confirm new kernel version after reboot

$ cat /sys/kernel/debug/dri/0/i915_gpu_info //Confirm GPU firmware loaded successfully
```



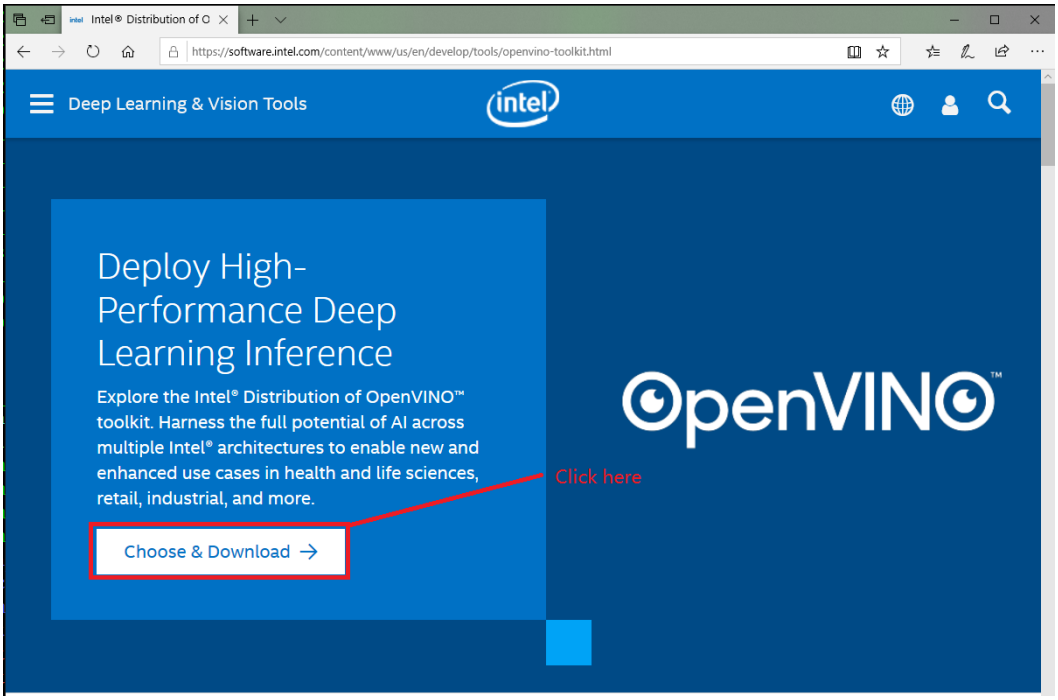
1.3 Install OpenVINO 2021.1

If user only want to run media related performance evaluation without inference, there is no need to install OpenVINO. User can skip this chapter and check Chapter 1.7 for how to build SVET without OpenVINO. Note, without OpenVINO, all the inference related par files aren't supported.

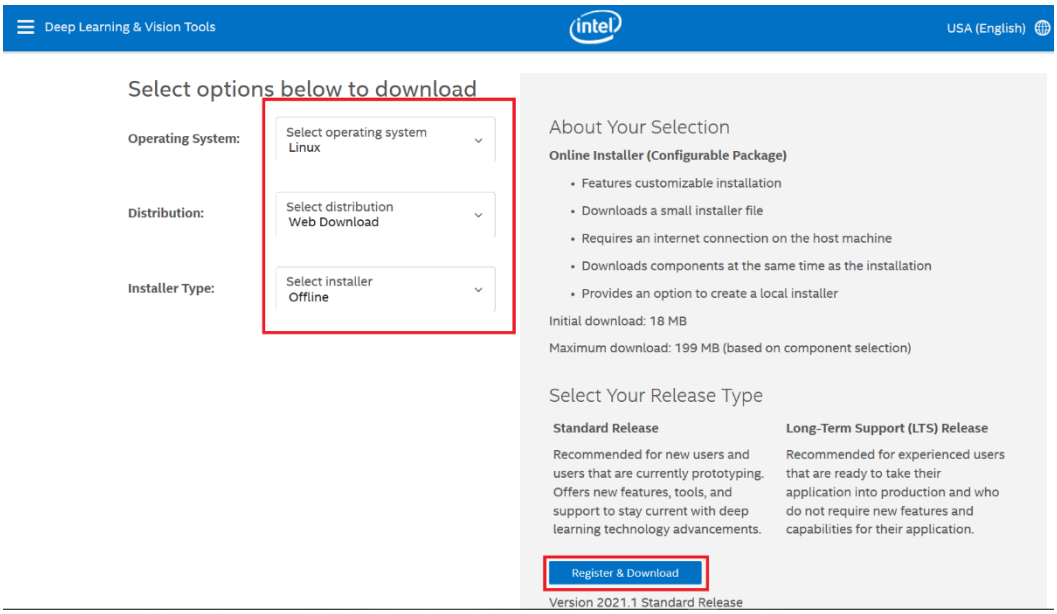
1.3.1 Download OpenVINO package

The sample application video_e2e_sample depends on OpenVINO libraries. We suggest users to install OpenVINO 2021.1 Linux package from *https://software.intel.com/en-us/openvino-toolkit*

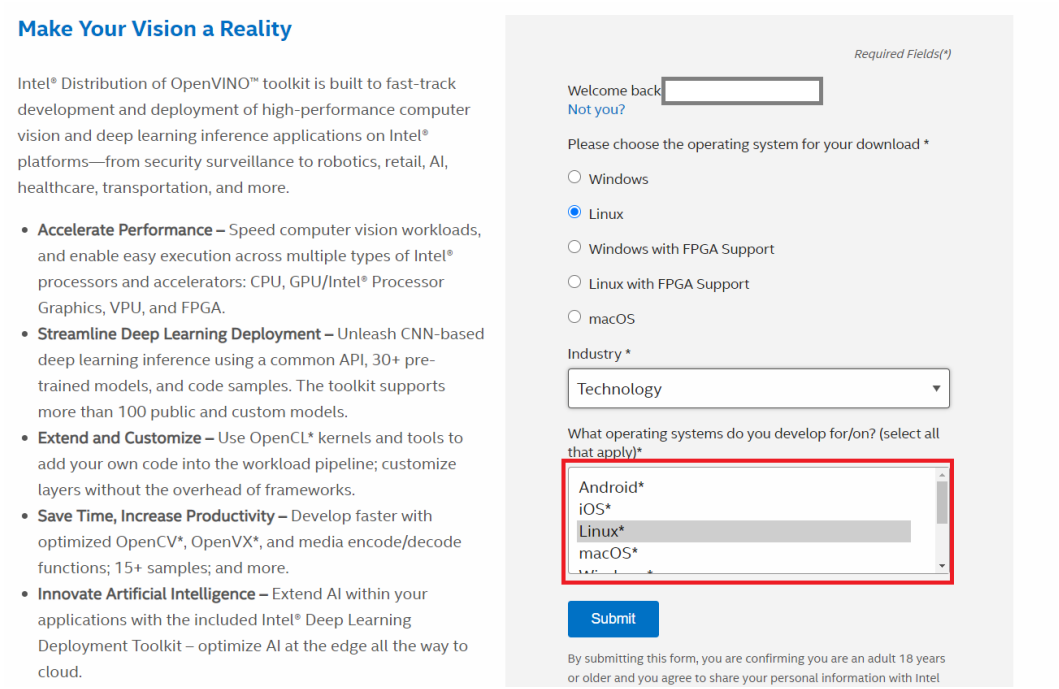
Please use browser Edge, Chrome, Safari or Firefox to open the above URL. Click the "Choose & Download" button.



Please select “Linux”, “Web Download”, “Offline” in options. Then click “Register & Download”. See below picture.

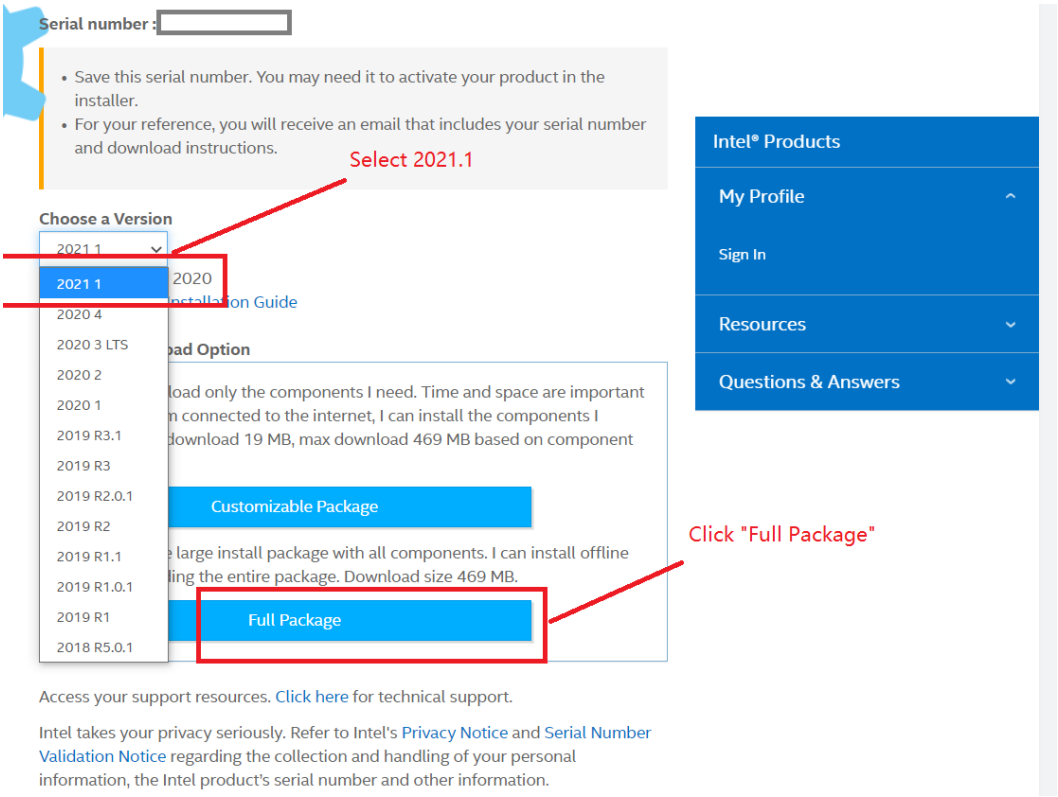


In next page, you may need to fill out registry information if you didn’t login with your Intel account.



In the OpenVINO downloading page, please make sure version “2021.1” is select. Otherwise, it might download other version and cause SVET compiling or runtime error.

Then click “Full Package” and the downloading will begin. See below picture.



1.3.2 Install OpenVINO

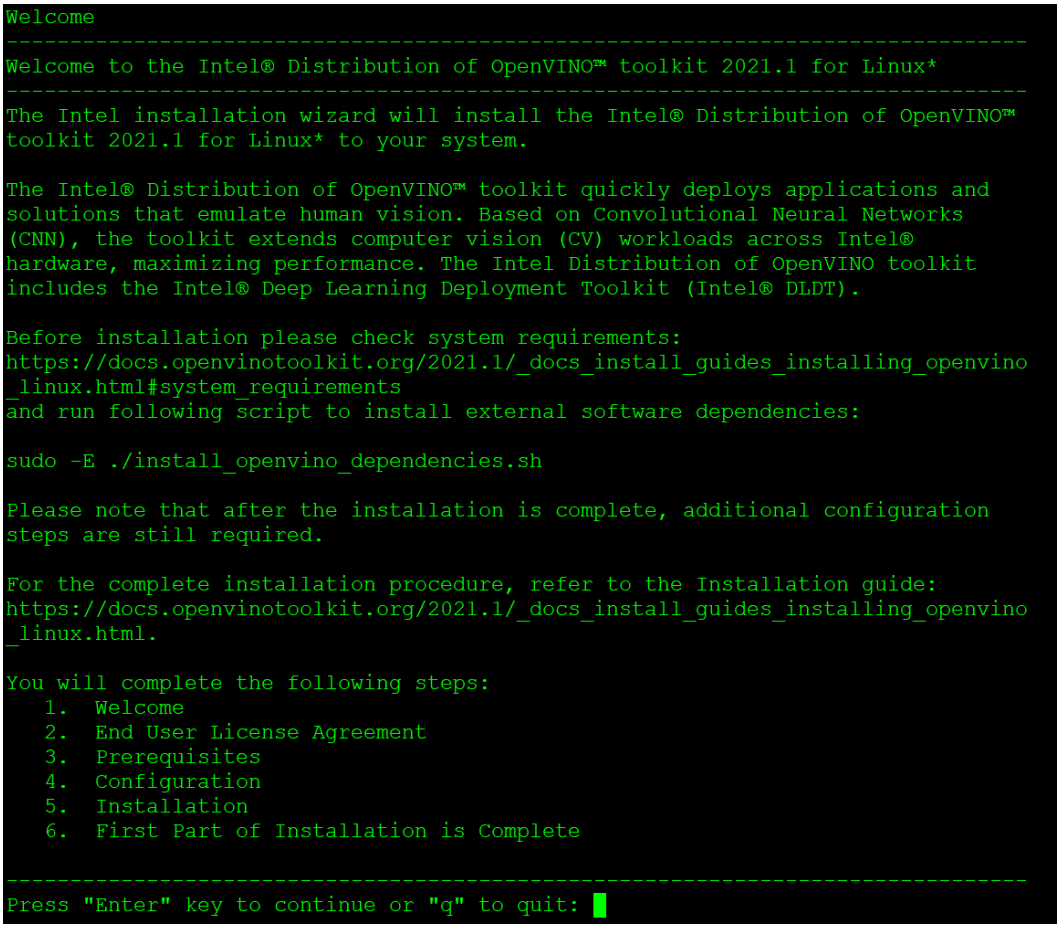
Firstly, please use below command to uncompress the package:

```
$tar zxf l_openvino_toolkit_p_2021.1.110.tgz
```

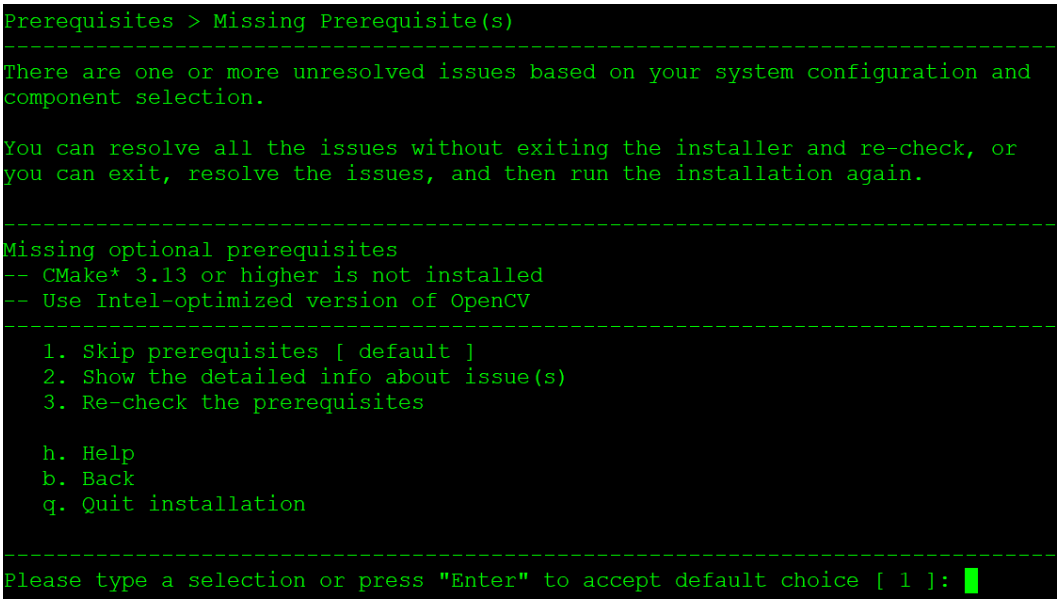
Please uninstall the old version of OpenVINO if it has been installed before.

Then please run the installation script wit sudo:

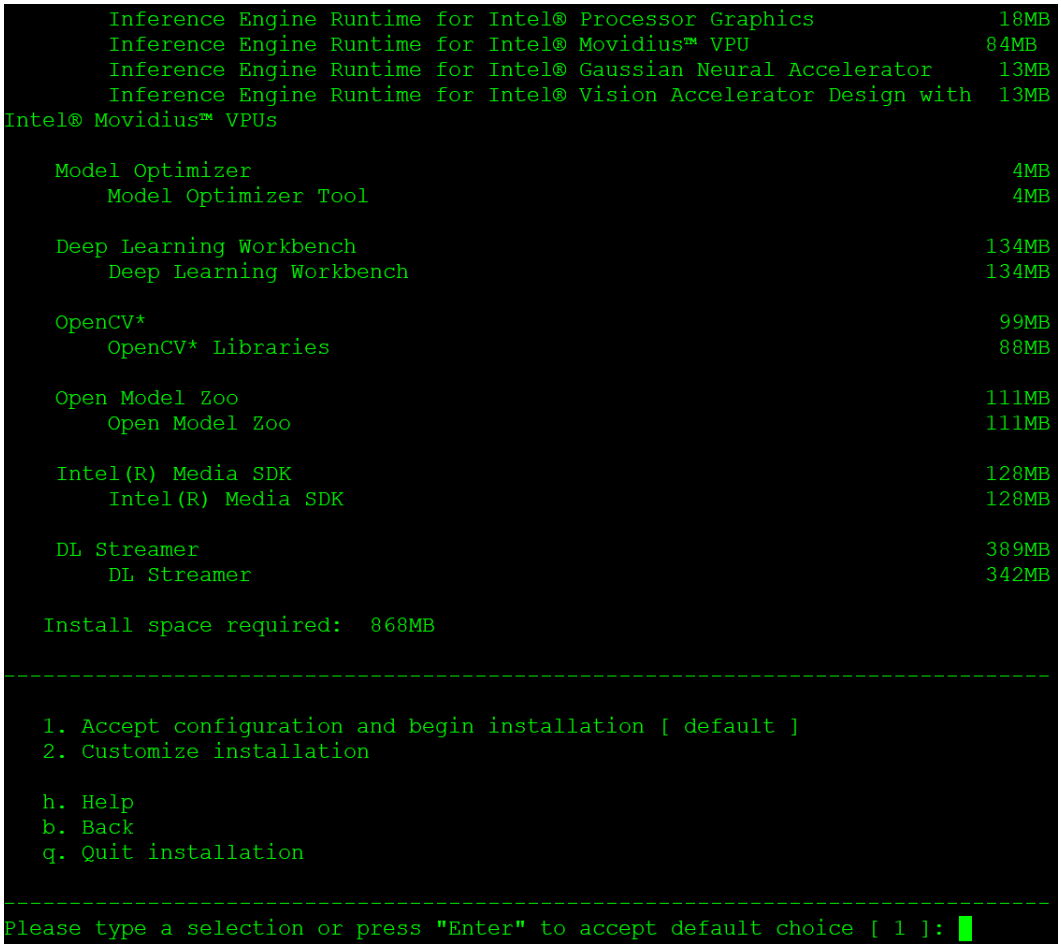
```
$cd l_openvino_toolkit_p_2021.1.110

$sudo ./install.sh
```



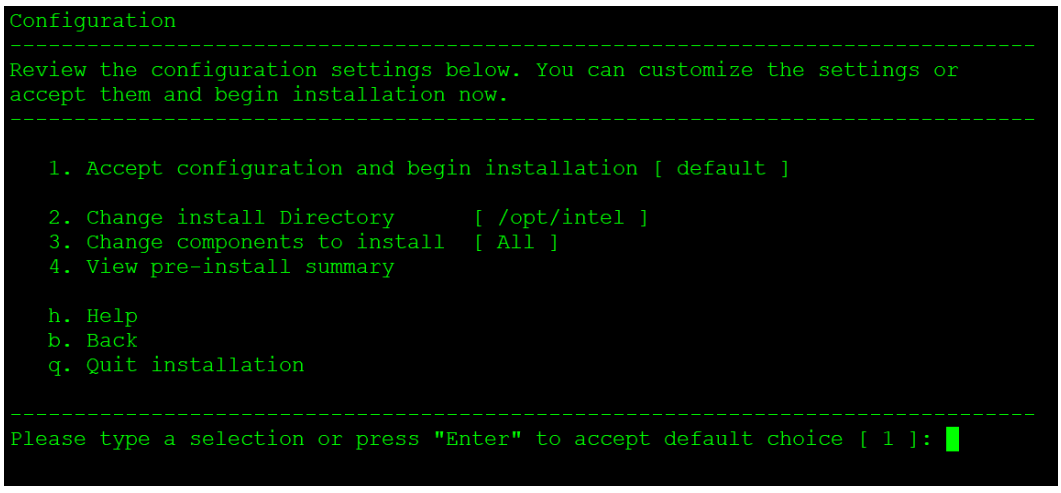
Please following the instructions to complete the installation. Type “Enter” to continue. Then type “accept” to continue. Type “1” to continue and you’ll see below picture:



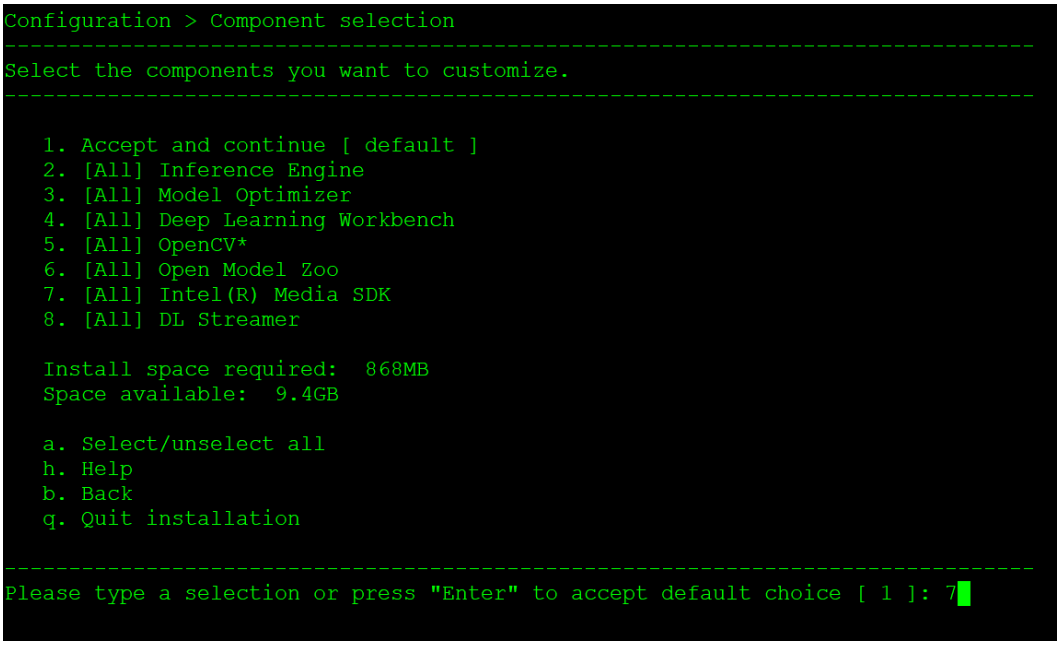
Select “1” to skip prerequisites in this step and you’ll see below installation configuration page. Since MediaSDK will be downloaded and installed by SVET script, there is no need to install MediaSDK during OpenVINO installation.



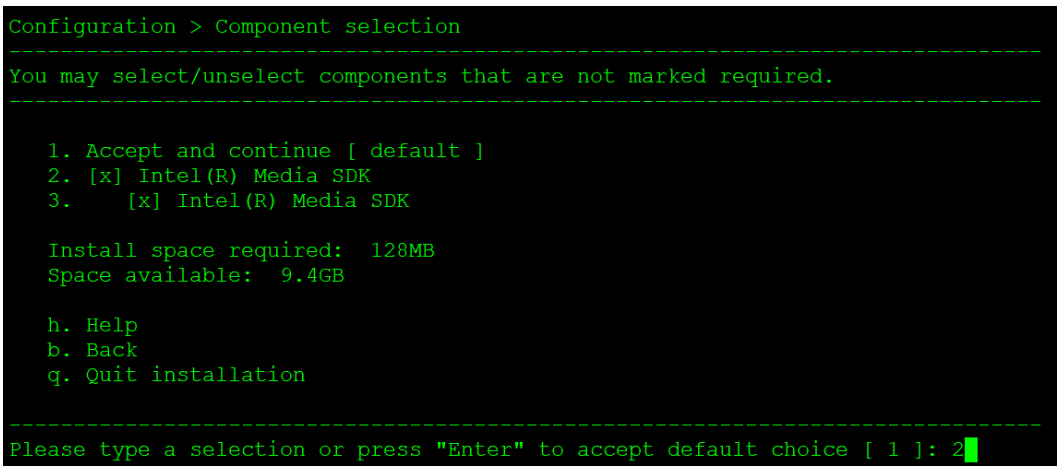
Please select “2” to go to customized installation page. Then select “3” to change components to install.



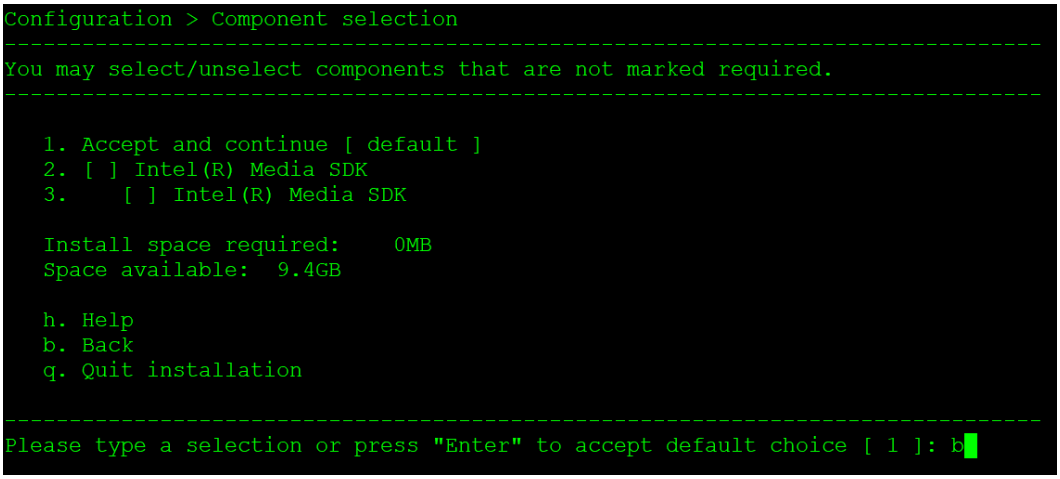
Type “7” to select MediaSDK in the component list.

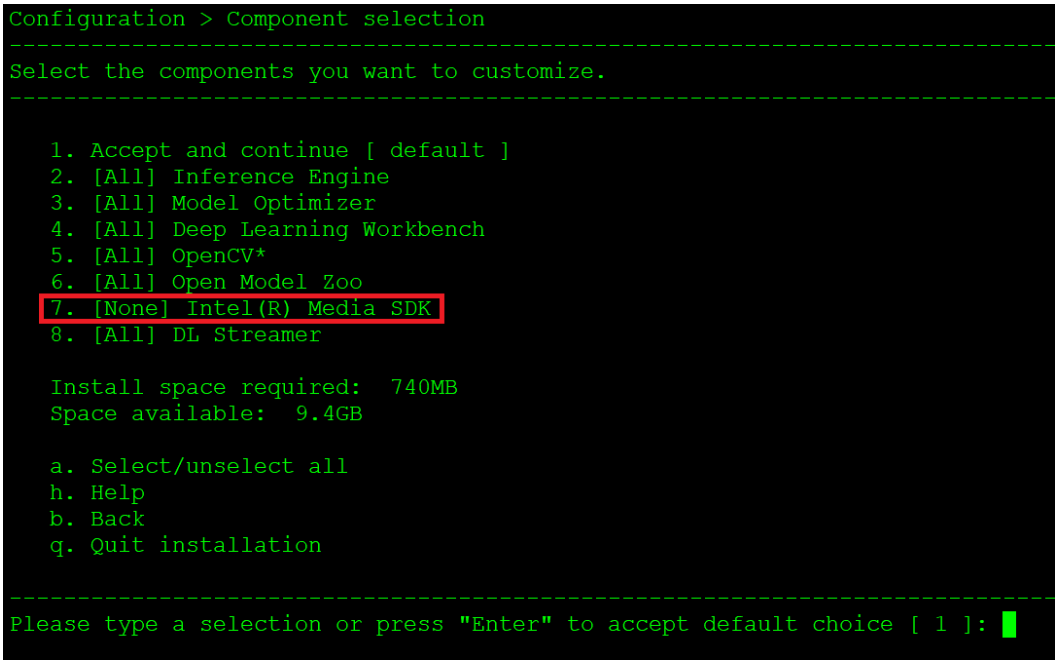


Then, type “2” to unselect MediaSDK from components list.

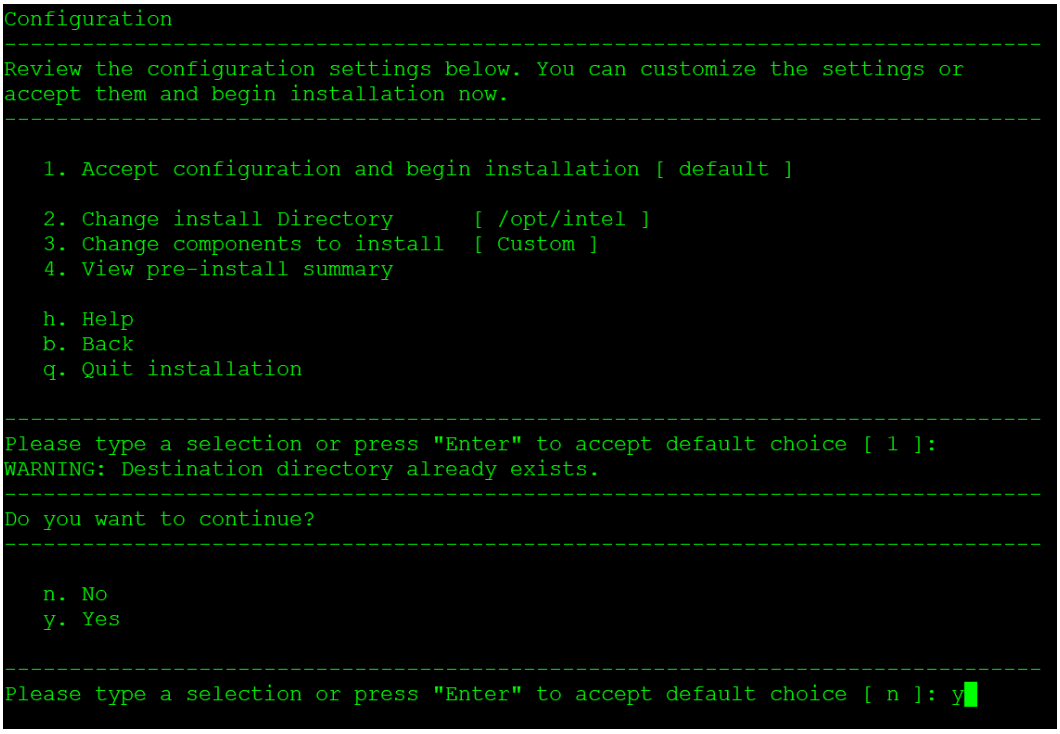


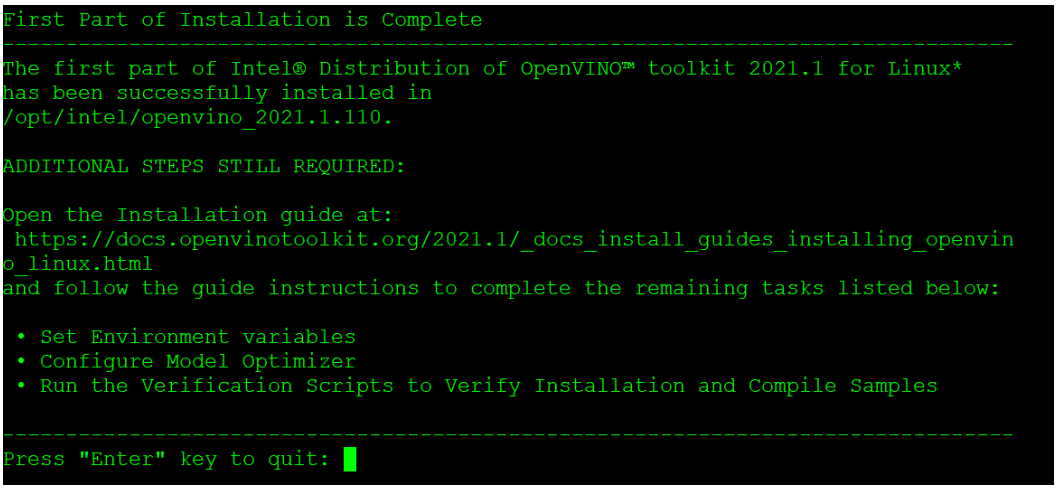
Finally, type “b” to go back and type “Enter” twice to begin installation.





If you had installed OpenVINO to /opt/intel/ before, it will need confirmation. Please type “y” as shown in below picture.





The installation will complete in a few minutes. Please run below command and also add it to ~/.bashrc. This command runs the OpenVINO environment variables setting up script. SVET build scripts depends on these environment variables.

```
$ source /opt/intel/openvino_2021/bin/setupvars.sh
```

By default, OpenVINO is installed to "/opt/intel/openvino". It also can be installed to ~/intel/openvino. In this case, please replace "/opt/intel/openvino" with "~/intel/openvino" in the following instructions in this document.

If you're not using Tiger Lake U, make sure the OpenCL driver is installed correctly by running "sudo /opt/intel/openvino/install_dependencies/install_NEO_OCL_driver.sh". **If you are using Tiger Lake U, please following instructions in Chapter 1.3.3 to install OpenCL NEO driver manually.**

If you see below error message during the installation of NEO OCL driver:

```
dpkg: dependency problems prevent removal of intel-igc-core:
 intel-igc-opencl depends on intel-igc-core (= 1.0.10-2407).
dpkg: error processing package intel-igc-core (--remove):
 dependency problems - not removing
Errors were encountered while processing:
 intel-igc-core
```

Please try to uninstall intel-igc-opencl and intel-igc-core manually by bellow commands:

```
sudo dpkg -r intel-igc-opencl
sudo dpkg -r intel-igc-core
```

Then re-run command "sudo /opt/intel/openvino/install_dependencies/install_NEO_OCL_driver.sh"

Run "source /opt/intel/openvino/bin/setupvars.sh" and add "source /opt/intel/openvino/bin/setupvars.sh" to .bashrc under home directory. This step is important because both the building and running of video_e2e_sample can fail if setupvars.sh doesn't run firstly in the same bash.

1.3.3 Tiger Lake U: Install OpenCL NEO driver 20.52.18783

If you're using Tiger Lake U, The OpenCL NEO driver need to be installed manually. Please install NEO r 20.52.18783 according to NEO r20.52.18783 release

$ apt install clinfo

You will see below information if the NEO driver installed correctly.

```
root@tgl-Tiger-Lake-Client-Platform:/home/tgl/james/neo# clinfo
Number of platforms                               1
  Platform Name                                   Intel(R) OpenCL HD Graphics
  Platform Vendor                                 Intel(R) Corporation
  Platform Version                                OpenCL 2.1
  Platform Profile                                FULL_PROFILE
  Platform Extensions                             cl_khr_byte_addressable_store cl_khr_fp16 cl_khr_glob
_khr_local_int32_extended_atomics cl_intel_subgroups cl_intel_required_subgroup_size cl_intel_subgroups
e_hints cl_khr_create_command_queue cl_intel_subgroups_char cl_intel_subgroups_long cl_khr_il_program c
nified_shared_memory_preview cl_khr_mipmap_image cl_khr_mipmap_image_writes cl_intel_planar_yuv cl_inte
epth_images cl_intel_media_block_io cl_khr_3d_image_writes cl_intel_va_api_media_sharing cl_intel_subgr
  Platform Host timer resolution                  1ns
  Platform Extensions function suffix             INTEL

  Platform Name                                   Intel(R) OpenCL HD Graphics
Number of devices                                 1
  Device Name                                     Intel(R) Gen12LP HD Graphics NEO
  Device Vendor                                   Intel(R) Corporation
  Device Vendor ID                                0x8086
  Device Version                                  OpenCL 2.1 NEO
  Driver Version                                  20.18.16699
  Device OpenCL C Version                         OpenCL C 2.0
```

1.4 Build concurrent video analytic sample application and dependent libraries

Download the source code and run the build_and_install.sh script with below commands:

```
$git clone https://github.com/intel-iot-devkit/concurrent-video-analytic-pipeline-optimization-sample-l.git cva_sample
$ cd cva_sample
$./build_and_install.sh
        [ INFO ] Working directory: /home/work/vaas_e2e_sample_l

        ********************************************************************************
        [ INFO ] Install required tools and create build environment.
        ********************************************************************************
        Please input the sudo password to proceed

[sudo] password for userxxx:
```

It will install dependent libraries, download and build Media SDK, media-driver, libva and libva-util. It can take 10 to 20 minutes that depends your network bandwidth. It will ask password for “sudo” command. Please input the “sudo” password to continue the installation.

Please note if libva, media-driver and Media SDK libraries have been installed to /usr/lib/x86_64-linux-gnu/ and /opt/intel/mediasdk/, original version of these libraries will be overwritten. If libva has been installed to /usr/lib or any other path in $LD_LIBRARY_PATH, please uninstall the libraries and header files firstly. Otherwise, Media SDK and media-driver can refer to wrong libva header files or link to wrong libva libraries.

Below table list the detailed steps in build_and_install.sh. If any step fails, user can try to find the corresponding commands and run them manually.

Step Description		**Expected Results**
Check if directory $INTEL_OPENVINO_DIR exists.		Environment variable INTEL_OPENVINO_DIR has been set correctly.
Run ./msdk_pre_install.py	Run apt install to install dependent libraries	apt command runs successfully
	Download libva, libva-util, gmm-lib, media-driver, Media SDK source code for Media SDK 2020.3 release.	Source code libva, libva-util, gmm-lib, media-driver, MediaSDK are downloaded into currently directory.
	Build and install libva, libva-util, gmm-lib, media-driver	Build and install libva and media-driver libraries to /usr/lib/x86_64-linux-gnu/ successfully.
Apply patches under patch/ to Media SDK, then build and install MediaSDK libraries.		A symbol link ./bin/ is created which links to MediaSDK/build/__bin/release/. And Media SDK libraries are installed to /opt/intel/mediasdk/
Add libva and Media SDK environment variable setting commands to .bashrc and also run these commands in current bash.		Add bellow commands to ~/.bashrc if they are not added before. vainfo can run successfully export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:/usr/lib/x86_64-linux-gnu:/usr/lib export LIBVA_DRIVERS_PATH=/usr/lib/x86_64-linux-gnu/dri export LIBVA_DRIVER_NAME=iHD export MFX_HOME=/opt/intel/mediasdk LD_LIBRARY_PATH="$LD_LIBRARY_PATH:/opt/intel/mediasdk/lib
Install MediaSDK sample_common header files and libraries. Then build video_e2e_sample.		Copy the Media SDK/sample/sample_common header files to /opt/intel/mediasdk/include/sample_common and copy the libsample_common.a to /opt/intel/mediasdk/lib/. A directory “build” will be created under video_e2e_sample. Then command “cmake ../; make -j4” will be run under “build” folder. After building is completed, cva_sample /bin/video_e2e_sample is the sample application binary

Run script/download_and_copy_models.sh to download OpenVINO face detection, human pose estimation and vehicle detection models IR files to directory model/	$ ls model/ face-detection-retail-0004.bin vehicle-attributes-recognition-barrier-0039.bin face-detection-retail-0004.xml vehicle-attributes-recognition-barrier-0039.xml human-pose-estimation-0001.bin vehicle-license-plate-detection-barrier-0106.bin human-pose-estimation-0001.xml vehicle-license-plate-detection-barrier-0106.xml

1.5 Verify sample application's dependency

If build_and_install.sh runs successfully, now run vainfo and you can see below output

```
l$ vainfo
error: can't connect to X server!
libva info: VA-API version 1.9.0
libva info: User environment variable requested driver 'iHD'
libva info: Trying to open /usr/lib/x86_64-linux-gnu/dri/iHD_drv_video.so
libva info: Found init function __vaDriverInit_1_9
libva info: va_openDriver() returns 0
vainfo: VA-API version: 1.9 (libva 2.9.0)
vainfo: Driver version: Intel iHD driver for Intel(R) Gen Graphics - 20.3.0 (dcc5f0e)
vainfo: Supported profile and entrypoints
    VAProfileNone               : VAEntrypointVideoProc
    VAProfileNone               : VAEntrypointStats
    VAProfileMPEG2Simple        : VAEntrypointVLD
    VAProfileMPEG2Simple        : VAEntrypointEncSlice
    VAProfileMPEG2Main          : VAEntrypointVLD
    VAProfileMPEG2Main          : VAEntrypointEncSlice
    VAProfileH264Main           : VAEntrypointVLD
    VAProfileH264Main           : VAEntrypointEncSlice
```

```
        VAProfileH264Main       : VAEntrypointFEI
        VAProfileH264Main       : VAEntrypointEncSliceLP
        VAProfileH264High       : VAEntrypointVLD
        VAProfileH264High       : VAEntrypointEncSlice
        VAProfileH264High       : VAEntrypointFEI
        VAProfileH264High       : VAEntrypointEncSliceLP
        VAProfileVC1Simple      : VAEntrypointVLD
    ....
```

And use below command to check if there are any missing libraries:

```
ldd ./bin/video_e2e_sample  | grep "not found"
```

If there is any library not found, it means the installation wasn't completed. Please contact your account manager from Intel and send the output of above command in email

1.6 Prepare the video clips for testing

If you don't have video clip for testing, you can download sample videos for face detection from https://raw.githubusercontent.com/intel-iot-devkit/sample-videos/master/head-pose-face-detection-male.mp4, human pose estimation from https://github.com/intel-iot-devkit/sample-videos/blob/master/classroom.mp4 and vehicle detection sample video from https://github.com/intel-iot-devkit/sample-videos/blob/master/car-detection.mp4. Since this sample application only supports element stream, you can use bellow command to extract the element stream from MP4 file:

```
ffmpeg -i classroom.mp4 -vcodec copy -an -bsf:v h264_mp4toannexb classroom.h264
```

After that, classroom.h264 can be used as input video stream.

1.7 Build concurrent video analytic sample application without OpenVINO

Some of our customers only care about media performance and don't need inference features. In this case, user can build SVET sample application without OpenVINO installation.

The build command is shown as below:

```
./build_and_install.sh -b no_ocv
```

With option "-b no_ocv", the build script won't check the environment variable INTEL_OPENVINO_DIR and use a special cmake configuration file which excluded the inference related source code.

2.0 Run sample application video_e2e_sample

2.1 Check environment variables

Using below commands to check if environment variables LIBVA_DRIVERS_PATH and INTEL_OPENVINO_DIR set correctly.

```
$echo $LIBVA_DRIVERS_PATH

/usr/lib/x86_64-linux-gnu/dri

$echo $INTEL_OPENVINO_DIR

/opt/intel/openvino_2021
```

2.2 Modify the video path in parameter file

Modify the video path (following "-i::h264") of **every line** in example par file s under face_detection_1080p_16_channel.par. Please use absolute path of testing video clip.

```
-i::h264 /home/work/video/classroom.h264 -join -hw -async 10 -dec_postproc -threads 2 -o::sink -vpp_comp_dst_x 0 -vpp_comp_dst_y 0 -vpp_comp_dst_w 480 -vpp_comp_dst_h 270 -ext_allocator -infer::fd ./model
```

Otherwise you will see below error message when run the sample application

```
[ERROR], sts=MFX_ERR_NULL_PTR(-2), Init, m_fSource pointer is NULL at /home/work/video_e2e_sample_l/MediaSDK/samples/video_e2e_sample/src/file_and_rtsp_bitstream_reader.cpp:165
```

2.3 Enable cl_cache

The loading of inference models can take long time. It's recommended to enable OpenCL kernel cache. By default, script build_and_install.sh adds command "mkdir ~/cl_cache" and "export cl_cache_dir=~/cl_cache" to .bashrc. So the cl_cache is enabled after running script build_and_install.sh. You can use command "echo $cl_cache_dir" to confirm cl_cache is enabled in current bash terminal.

It's recommended to clear directory $cl_cache_dir when you upgrade OpenVINO in the future.

For cl_cache details, please refer to https://github.com/intel/compute-runtime/blob/master/opencl/doc/FAQ.md

2.4 Run video_e2e_sample application

Before running video_e2_sample with “-rdrm-DisplayPort” in par file, you must switch ubuntu to text mode by “Ctrl + Alt + F3”. And then switch to root user by “su -p” because the DRM direct rendering requires root permission and no X clients running. If there is alive VNC sessions, please close them firstly. The “-p” option is to keep the current user environment variables settings.

If user wants to run video_e2_sample with normal user or with X11 display, user can replace “-rdrm-DisplayPort” with “-rx11”. See par_file/inference/n16_face_detection_1080p_x11.par for inference. Note, X11 rendering isn’t as efficient as DRM direct rendering. According to our 16-channel face detection test on Coffee Lake, the average time cost of processing one frame increased by 6ms compared to using DRM direct rendering.

There are many par files under folder par_file. This chapter lists example par files for several typical use cases. Please refer to Chapter 2.4 for the detailed information of parameters in par files.

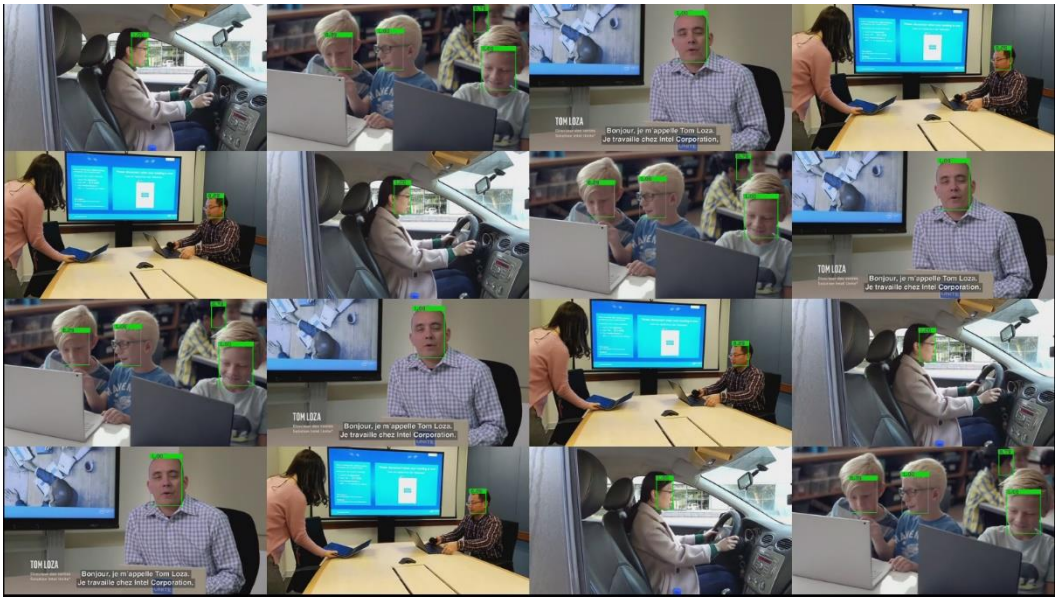
2.4.1 16-channel video decoding, face detection, composition, encode and display

Command line:

```
./bin/video_e2e_sample -par par_file/inference/n16_face_detection_1080p.par
```

The face detection inference is specified by “-infer::fd ./model” in the par file. “ ./model “ is the directory that stores face detection model IR files.

The first loading of face detection models to GPU is slow and you might need to wait for a minute until the video showing on display as below screenshot. Then with cl_cache enabled, the next running of face detection models will be much faster, which is about 10 seconds on CFL.



If you want to stop the application, press “Ctrl + c” in the bash shell.

If you want to play 200 frames in each decoding session, you can append “-n 200” to parameters lines starting with “-i” in par files.

By default, the pipeline is running as fast as it can. If you want to limit the FPS to a certain number, please add “-fps FPS_number” to every decoding sessions, which start with “-i” in par files. Please refer to par_file/inference/ n16_1080p_face_detect_30fps.par.

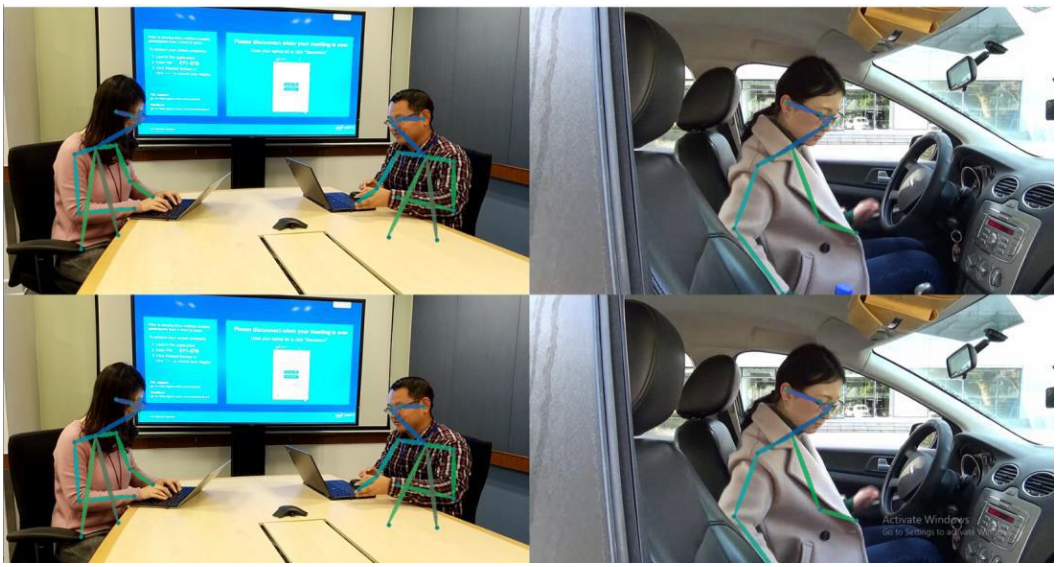
2.4.2 4-channel video decoding, human pose estimation, composition, and display

Command line:

```
./bin/video_e2e_sample -par par_file/inference/n4_human_pose_1080p.par
```

The face detection inference is specified by “-infer::hp ./model” in the par file. “ ./model “ is the directory that stores human pose estimation model IR files.

Below picture is the screenshot of this demo.



2.4.3 4-channel video decoding, vehicle and vehicle attributes detection, composition, encode and display

Command line:

```
./bin/video_e2e_sample -par par_file/inference/n4_vehicel_detect_1080p.par
```

The vehicle and vehicle attributes detection inference is specified by "-infer::vd ./model" in the par file. " ./model " is the directory that stores vehicle and vehicle attributes detection model IR files.

Below picture is the screenshot of this demo.

2.4.4 16-channel RTSP video decoding, face detection, composition, encode and display

Command line:

```
./bin/video_e2e_sample -par par_file/rtsp/n16_face_detection_1080p.par
```

To use RTSP video stream instead of local video file, you can modify the par file and use RTSP URL to replace local video file path.

```
-i::h264 rtsp://192.168.0.8:1554/simu0000  -join -hw  -async 4 -dec_postproc   -o::sink -vpp_comp_dst_x 0 -vpp_comp_dst_y 0 -vpp_comp_dst_w 480 -vpp_comp_dst_h 270 -ext_allocator -infer::fd ./model
```

2.4.5 Offline inference mode

The results of inference are rendered to the composition by default. It can be disabled by add parameter "-infer::offline" after "-infer::fd ./model", then the result of inference won't be rendered.

2.4.6 Shared inference network instance

Starting from R3, the sessions that use same network IR files and same inference device shared one inference network instance. The benefit is that when GPU plugin is used, the network loading time decreases by 93% for 16-channel inferences.

2.4.7 16-channel RTSP video decoding, RTSP stream storing, face detection, composition, encode, and display

Command line:

```
./bin/video_e2e_sample -par par_file/rtsp/n16_face_detection_rtsp_save.par
```

The name of RTSP streaming local file is specified by option "-rtsp_save filename" in decoding session in par file. User can choose one or more sessions to invoke the RTSP stream storing.

2.4.8 2-channel RTSP stream storing

Command line:

```
./bin/video_e2e_sample -par par_file/rtsp/rtsp_dump_only.par
```

When there are only "-i" and "-rtsp_save" options in par file, the session won't run decode or inference or display but only save the specified RTSP stream to local file.

Please note, such sessions must be put into one separated par file. If you'd like to run RTSP stream storing sessions together with other decoding and inference sessions, you can run with two par files. For example

Command line:

```
./bin/video_e2e_sample -par par_file/rtsp/rtsp_dump_only.par
par_file/rtsp/n16_face_detection_rtsp_save.par
```

2.4.9 Multiple displays

Below is an example to run 16 1080p decode sessions on one display and run 4 1080p decode and inference sessions on another display.

Please note: if the two par files specify different resolutions for display, e.g. 1080p and 4k, and there is one 1080p and one 4k monitors connects to the device, this command line could run into error due to 4k par file selecting 1080p monitor, in this case, you can try to switch the order of par files passed to video_e2e_sample. In current implementation, "-rdrm-XXXX" options are ignored. Sample application will choose the first unused display emulated from the DRM for each par file. The order is according to the CRTC id showed in "/sys/kernel/debug/dri/0/i915_display_info". Display with smaller CRTC id is emulated earlier. Generally, the first par file in the command can get the display with smallest CRTC id. But since we create different thread for each par file, the actual order of display assigned to each par file may not be strictly the same as the order of par file in the command.

Command line:

```
./bin/video_e2e_sample -par par_file/basic/n16_1080p_30fps_videowall.par par_file/basic/
n16_1080p_30fps_videowall.par
```

2.4.10 Use fake sink

By using option "-fake_sink", user can run the concurrent video decoding with fake sink instead of display or encoder. In this mode, the composition of decoding or inference result is disabled. Please refer to example par files n16_1080p_decode_fakesink.par under folder par_file/misc and n16_1080p_face_detection_fakesink.par under folder par_file/inference.

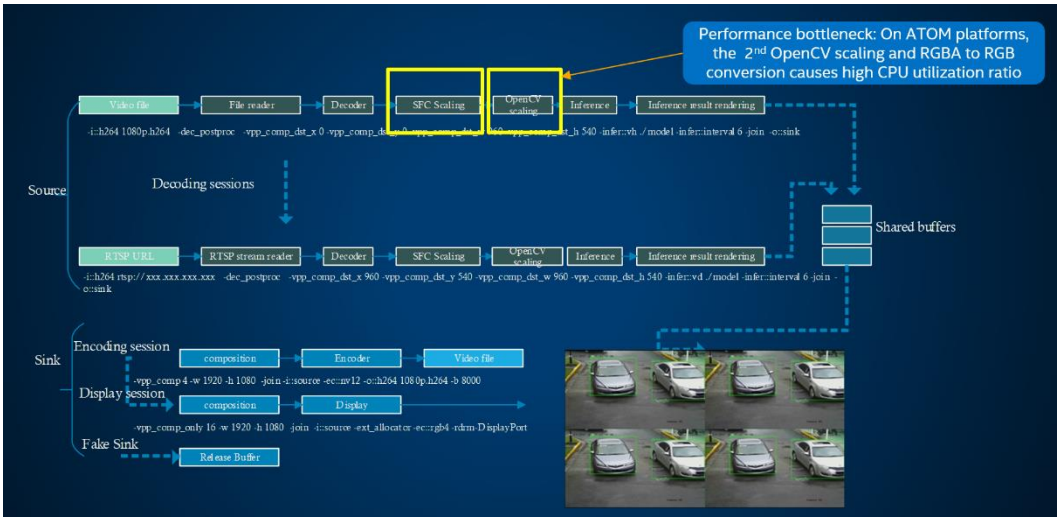
2.4.11 Use VPP instead of SFC in decoding session

H265 decoder doesn't support SFC, so VPP(Accelerated by Execution Unit in Intel Graphics) is used for scaling and color format convert in video decoding sessions. Please refer to example par file n16_1080p_h265_fd.par under folder par_file/inference and n16_h265_1080p_rtsp_simu.par under folder par_file/rtsp.

2.4.12 Enable two outputs from video decoder.

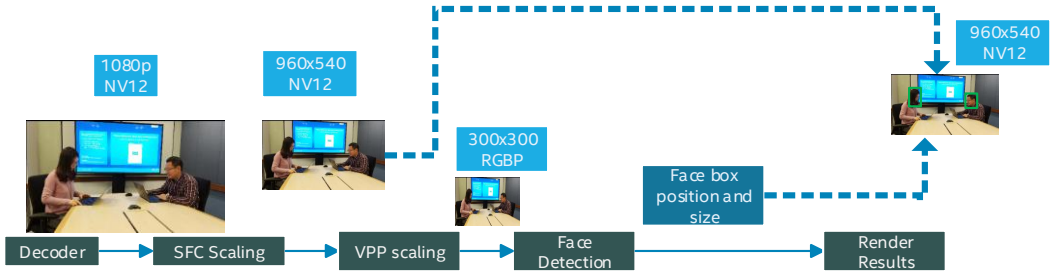
As you can see in below diagram of SVET pipeline, there are 2 scaling stages. The first one is done by GPU. The output size of first scaling is specified by vpp_comp_width and vpp_comp_height parameters in par file. The second one is done with OpenCV by CPU. And its input is the output of first scaling and its output size is set according to the

input size of inference network. On ATOM platforms, we notice that the second scaling cost too much CPU computing resource and it impacts the whole pipeline performance.



Starting from R3, SVET supports enabling two outputs from video decoder by adding "-dc::rgbp" to each decoding session. As you can see in below picture, one output is from SFC with size equal to the composition input size in NV12 format. And the other is from VPP with size equal to inference input size and in RGBP format. This option only can be used together with "-infer::fd".

With this optimization, for 4-channel face detection on APL platform, the CPU utilization ratio is reduced by half.



2.4.13 Configurate the inference target device, inference interval and maximum object number

By default, GPU is used as inference target device. User can also use option "-infer::device HDDL" to specify HDDL as target device. User can also use option "-infer::device CPU" to specify CPU as target device.

In one par file, user can use different devices for each session.

If HDDL is used as inference engine, please firstly make sure the HDDL device has been set up successfully. See n4_vehicel_detect_hddl_1080p.par for inference.

The option “-infer::interval” indicates the distance between two inference frames. For example, “-infer::interval 3” means frame 1, 4, 7, 10... will be sent to inference device and other frames will be skipped. For face detection and human pose estimation, the default interval is 6. For vehicle detection, the default interval is 1 which means running inference on every frame.

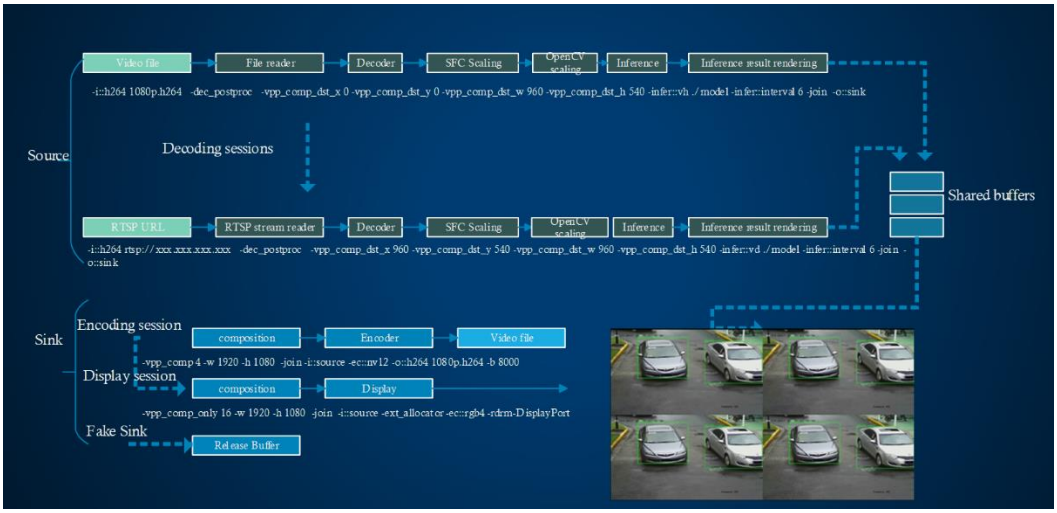
The option “-infer::max_detect” indicates the maximum number of detected objects for further classification or labeling. By default, there is no limitation of the number of detected objects.
Please refer to example par file n1_infer_options.par.

2.4.14 Configurate the interval of JPEG encoding

By using option “-frameskip”, user can specify interval for H264 to JPEG transcoding. See par_file/basic/n1_jpeg_enc_test.par and par_file/basic/n4_jpeg_enc_test.par.

2.5 Usage of media codec, inference and display parameters in par file

As you can see in below picture, the pipeline contains multiple sessions. Each session is defined by one line in par file. The session can be source or sink. The source session is decoding session and defined by lines starting with “-i”. The sink session can be encoding session that is defined “-vpp_com”, display session “-vpp_comp_only” or fake sink session “-fake_sink”. The source sessions add the decoded surfaces to the shared buffer queue while the sink sessions take the surfaces from shared buffer queue and release them when complete processing.



2.5.1 New parameters in Par file

Comparing to original video transcoding application sample_multi_transcode, we add some new parameters.

Parameter	Usage
-infer::infer_type ir_file_dir	Specify the inference type and directory that stores the IR files. Can be used together with -infer::offline. Examples: -infer::fd ./model →face detection -infer::hp ./model →human pose estimation -infer:vd ./model →vehicle and vehicle attributes detection -infer::fd ./model -infer::offline →face detection but not render the results to display -infer::fd ./model/person-detection-retail-0013.xml -> Person detection by specify the XML file directly
-i::h264 rtsp://url	Specify the source H264 file with RTSP URL
-rtsp_save filename.h264	Save RTSP stream to local file. This parameter must be used together with "-i::h264 rtsp://url". If the whole line of session parameters only contains "-i::h264 rtsp://url -rtsp_save filename.h264" and don't have other decoding parameters, we call such sessions as RTSP stream storing session and they must be put into a separated par file.

-dc::rgb4	Use VPP instead of SFC for scaling and color format conversion in decoding sessions. This option can't be used together with -dec_postproc. Please refer to n16_1080p_h265_fd.par and n16_h265_1080p_rtsp_simu.par.
-dc::rgbp	Enable two outputs from AVC video decoder. One is from SFC with size equal to the composition input size in NV12 format. And the other is from VPP with size equal to inference input size and in RGBP format. This option only can be used together with "-infer::fd".
-fake_sink <number of sources>	Use a fake sink instead of display(-vpp_comp) or encoding(-vpp_comp_only). This fake sink won't do composition of sources. The number of sources must be equal the number of decoding sessions. See n16_1080p_decode_fakesink.par and n16_1080p_infer_fd_fakesink.par for example. Please note, "-o" option must be used together with this option but it won't generate any output file.
-infer::device <GPU, CPU, HDDL>	Indicate the inference target device. Please refer to example par file n1_infer_options.par. If this option isn't set, GPU will be used as inference engine.
-infer::interval <number>	Indicate the distance between two inference frames Please refer to example par file n1_infer_options.par.
-infer::max_detect <number>	indicates the maximum number of detected objects for further classification or labeling. By default, there is no limitation of the number of detected objects. Please refer to example par file n1_infer_options.par.
-infer::remote_blob	Enable remote_blob feature of OpenVINO GPU plugin. Note, if this option is set, the decoder output will be in NV12 format with size equal to inference input size. There will be no display. So this option currently only support offline inference.
-frameskip interval	This option is only used in H264/H265 to JPEG transcoding. It's used to specify the interval of JPEG encoding. For example, with "-frameskip 5", on video frame will be encoded to JPEG every 5 frames. See par_file/basic/n1_jpeg_enc_test.par and par_file/basic/n4_jpeg_enc_test.par
-vpp_comp_dump null_render	Disabling rendering after VPP Composition. This is for performance measurements. See par_file/misc/n16_1080p_decode_vpp_comp_no_display.par
-o::raw /dev/null	when use "-o::raw" with output file name "/dev/null", application will drop the decode output frame instead of encoding or saving to local file. It's for pure video decoding testing.

2.5.2 Decode, encode and display parameters

Below table explains the parameters used in example par files. The full parameter list can also be found at https://github.com/Intel-Media-SDK/MediaSDK/blob/master/doc/samples/readme-multi-transcode_linux.md

Parameter	Usage
-i::h264 | h264 input_video_filename	Set input file and decoder type
-o::h264 | h265 output_video_filename	Set output file and decoder type
-o::sink	The output will be passed to the sink sessions,, e.g. encoding session or composition session
-i::source	The input is coming from source sessions like decoding session
-dec_postproc	Resize after decoder using direct pipe (should be used in decoder session)
-vpp_comp_dst_x 0 -vpp_comp_dst_y 270 -vpp_comp_dst_w 480 -vpp_comp_dst_h 270	(x, y) position and size of this stream in composed stream
-join	Join session with other session(s). If there are several transcoding sessions, any number of sessions can be joined. Each session includes decoding, preprocessing (optional), and encoding
-hw	GPU will be used for HW accelerated video decoding, encoding and post-processing.
-async <async_depth>	Depth of asynchronous pipeline.
-threads <thread_number>	Number of session internal threads to create
-ext_allocator	Force usage of external allocators
-n	Number of frames to transcode (session ends after this number of frames is reached). In decoding sessions (-o::sink) this parameter limits number of frames acquired from decoder. In encoding sessions (-o::source) and transcoding sessions this parameter limits number of frames sent to encoder.
-fps <fps>	Transcoding frame rate limit
-vpp_comp <sourcesNum>	Enables composition from several decoding sessions. Result is written to the file
-vpp_comp_only <sourcesNum>	Enables composition from several decoding sessions. Result is shown on screen.
-ec::nv12 | rgb4	Forces encoder input to use provided chroma mode.

-rdrm-DisplayPort	Using drm direct rendering. 'DisplayPort' will be ignored. The sample application will try to use the first DP or HDMI display it can connect to. Please switch Ubuntu to text mode(Ctrl + Alt + F3) and root user by command "su -p" before using this parameter.
-rx11	Using X11 as display. Please make sure environment variable DISPLAY set correctly if run the sample application remotely in a console terminal.

3.0 Pack video_e2e_sample Binaries and Install on Another Device

After install_and_build.sh script running successfully on one device, users can use scripts (pack_binary.sh, install_binary.sh) to pack and deploy video_e2e_sample to other devices with binaries only

3.1 Pack video_e2e_sample Binaries

pack_binary.sh can be used to copy video_e2e_sample and other dependent binaries into a folder.

Run below command under the source code directory and all video_e2e_sample and other dependent binaries will be copied to a folder named “cva_e2e_sample_l”.

```
$./script/pack_binary.sh

$ls cva_e2e_sample_l/

download_models.sh  libva       media-driver  par_file              video_e2e_sample

install_binary.sh   libva-utils  MediaSDK     run_face_detection_test.sh
```

3.2 Install video_e2e_sample Binaries

Users can also deploy the packed binaries with install_binary.sh script. Before that, please make sure Ubuntu 18.04 and OpenVINO have been installed on the new devices. Meanwhile on new device, the OpenVINO must be installed to the same path as the OpenVINO installation path on original device which video_e2e_sample is built on.

User can copy the folder “cva_e2e_sample_l” to the new device and run “sudo -E ./ install_binary.sh” under folder “cva_e2e_sample_l”. Then video_e2e_sample, libva, media-driver and Media SDK binaries will be installed. The script install_binary.sh also set environment variables LIBVA_DRIVERS_PATH, LIBVA_DRIVER_NAME and LD_LIBRARY_PATH variables with proper values.

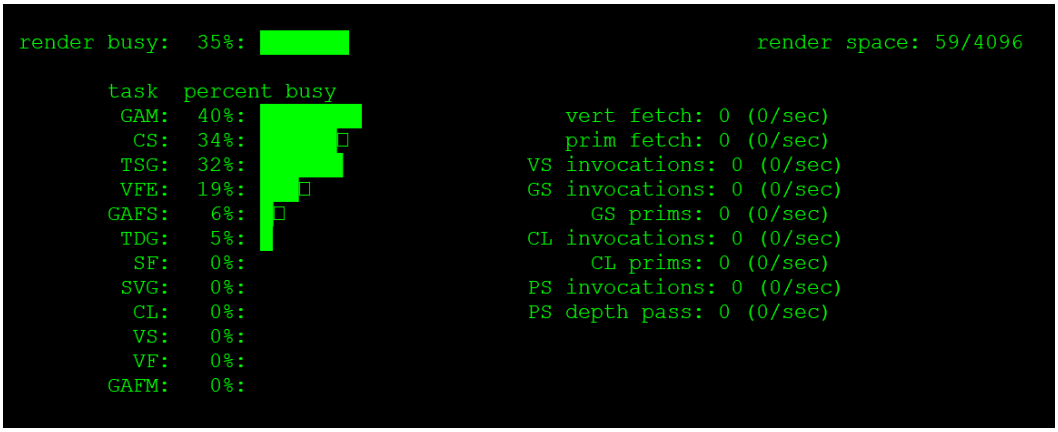
After running install_binary.sh successfully, the user can follow instructions in chapter 2 to run video_e2e_sample application with par files.

4.0 Monitor overall GPU resource usage statistics

There are some tools can be used to view GPU resource usage statistics. Please also refer to chapter 3.1.4 white paper CDI#621636

4.1 Intel_gpu_top

To install intel_gpu_top, run command “sudo apt install intel-gpu-tools”. Then run it with command “sudo intel_gpu_top”. “render busy” stands for the utilization of the programmable execution unit in Intel Graphics.



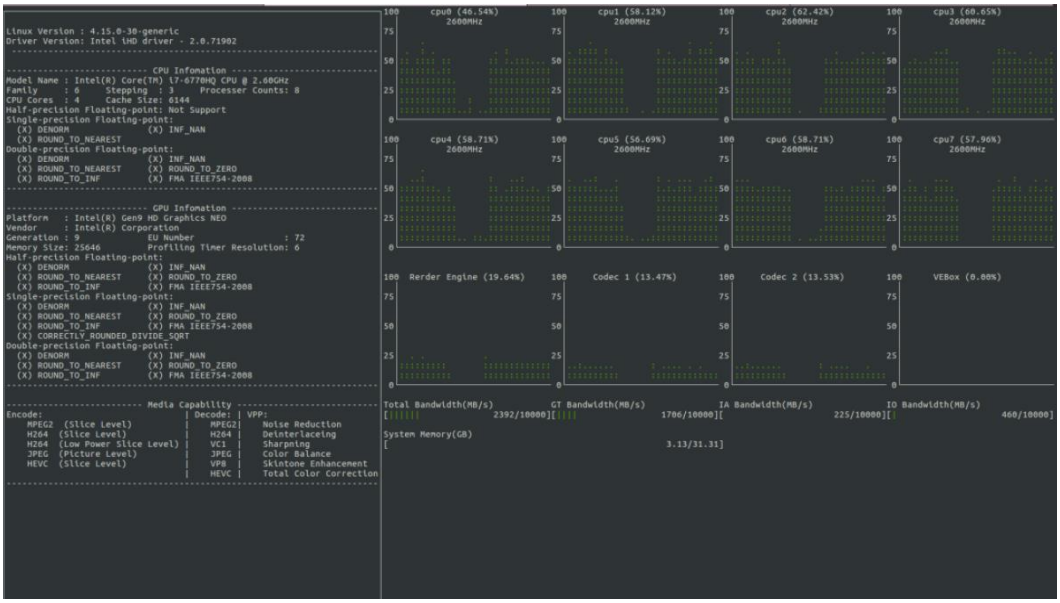
4.2 Intel-telemetry-tool

Intel-telemetry-tool is another open-source tool to monitor system resource utilization. It leverages some information from /proc & /sys file system to get static and run-time information. Compared to intel_gpu_top, it can monitor more sub-components such as VDBox and VEBox. User can toggle “s” to show static system information on the left. See intel-telemetry-tool for More details.

To download and run this tool, please refer to below commands:

```
$git clone https://github.com/Xiaogang-Li/intel-telemetry-tool.git

$cd intel-telemetry-tool

$./build.sh

$sudo -E ./build/tool/telemetry
```

Note, to view GPU resource utilization, user must use “sudo” to run this tool. Please wait one minute if there is no GPU resource usage statistics showing on screen.



Here is a screenshot of intel-telemetry-tool: