Smart Video Evaluation Toolkit – Linux* Concurrent Video Analytic Sample

Application User Guide

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Contents

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Revision History

Date	Revision	Description
2022/07/20	4.1	1.Update the openvino, linux kernel, libva, media-driver and oneVPL versions 2. Remove RGBP support
2021/05/13	4.0	1. Separated the installation guideline chapters for Tiger Lake and other platforms. 2. Added additional explanation on how to use this document at the beginning.
2021/03/24	4.0	1. Added descriptions for R4 new features (MOT) 2. Updated build script that installed MediaSDK can coexist with the previous media stack version installed in the same computer
2020/09/23	3.0	1. Updated the OpenVINO and Media SDK version 2. Added descriptions for R3 new features
2020/05/19	2.0	1. Updated the OpenVINO and Media SDK version 2. Added descriptions for R2 new features
2020/03/03	1.0	1. Added new example par files 2. Added tables to explain parameters usage in par file
2019/12/26	0.5	Initial release

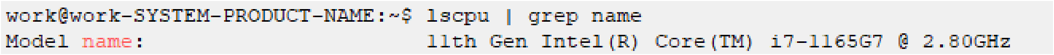
§

1.0 Installation Guide

In this chapter, you will learn how to install the **video_e2e_sample** application on Ubuntu* 20.04.03.

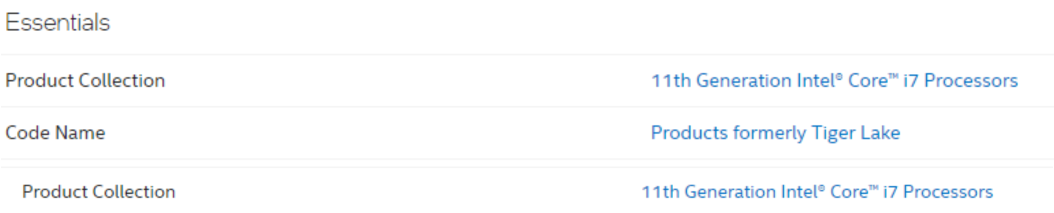
First, make sure the CPU is 11th or 12th Generation Intel® Core™ i7/i5/i3 or Celeron Processors. If the CPU model is 8th ~ 10th Generation Intel® Processors, you can use older version of **video_e2e_sample** application https://github.com/intel-iot-devkit/concurrent-video-analytic-pipeline-optimization-sample-l/releases/tag/v2021.1.3 that uses MediaSDK instead of oneVPL_gpu for video processing.

To get the CPU model name, run command "lscpu | grep name" and it can print the CPU model name like below:



```
work@work-SYSTEM-PRODUCT-NAME:~$ lscpu | grep name
Model name:                      11th Gen Intel(R) Core(TM) i7-1165G7 @ 2.80GHz
```

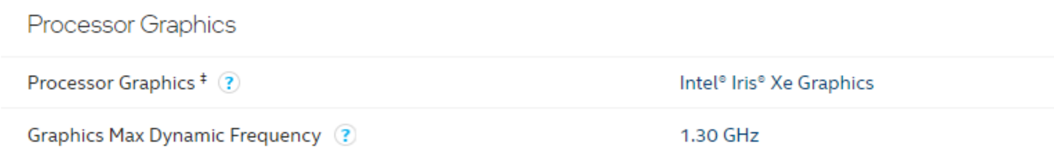
You can search the CPU model name on ark.intel.com and find the generation information:



Essentials

Product Collection	11th Generation Intel® Core™ i7 Processors
Code Name	Products formerly Tiger Lake
Product Collection	11th Generation Intel® Core™ i7 Processors

On the same specification page https://ark.intel.com/content/www/us/en/ark/products/208662/intel-core-i71165g7-processor-12m-cache-up-to-4-70-ghz.html, scroll down and you will find the "*Processor Graphics*", it means the CPU model has integrated graphics



Processor Graphics

Processor Graphics ‡ ?	Intel® Iris® Xe Graphics
Graphics Max Dynamic Frequency ?	1.30 GHz

If "*Processor Graphics*" is not found, it means the CPU doesn't have integrated graphics and the **video_e2e_sample** application won't be able to run.

1.1 System installation

Install Ubuntu* 20.04.03 and set up the network correctly and run *sudo apt update*.

1.2 Install Software Dependencies

The **video_e2e_sample** application depends on Intel media stack libva, media-driver and oneVPL for video decode, encode and post-processing functionalities. It depends on OpenVINO for inference.

If you are not going to use inference, but only video decode and encode, you can skip OpenVINO™ installation step, and refer to chapter 2.4.17 on steps to build the sample application without OpenVINO™.

In the root directory, you can find a bash script build_and_install.sh which can install Intel media stack libraries, build **video_e2e_sample** application, download the inference model IR files and test video clips. But before running this script, you need to follow the instruction in this chapter that upgrade the Linux kernel if needed, install OpenVINO, OpenCV and NEO runtime libraries.

1.2.1 Upgrade Linux Kernel to Intel LTS kernel version for 11th Generation Intel® Tiger Lake processors (optional)

The default Linux kernel of Ubuntu 20.04 is 5.13 which is good to work with Intel media stack. So for 11th Generation Intel® processors Tiger Lake, it's optional to upgrade the Linux kernel to Intel LTS kernel 5.10.90. Intel LTS kernel 5.10.90 back ported many i915 patches and is more stable.

Note: Back up your private files before upgrading Linux kernel in case the system is broken after restarting.

Make sure the network connection is stable and there is at least 15G free space in the system before running below commands.

Run below commands to download and install new Linux kernel for Tiger Lake:

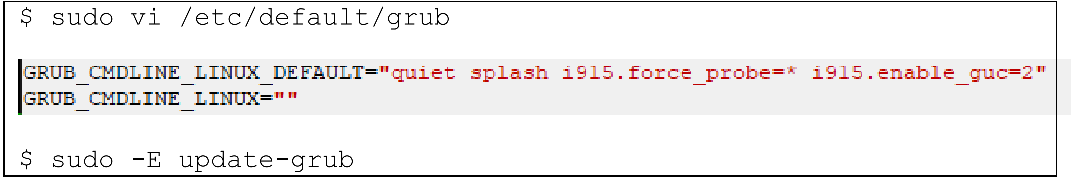
```
$sudo apt install coreutils build-essential bc kmod cpio flex
libncurses5-dev libelf-dev libssl-dev bison

$wget https://github.com/intel/linux-intel-
lts/archive/refs/tags/lts-v5.10.90-yocto-220208T044440Z.zip

$unzip lts-v5.10.90-yocto-220208T044440Z.zip

$cd linux-intel-lts-lts-v5.10.90-yocto-220208T044440Z

$make olddefconfig #Select the default value for unset config
items
$make -j8

$sudo -E make INSTALL_MOD_STRIP=1 modules_install

$sudo -E make install
```

Then install GPU firmware with the commands:

```
$wget https://github.com/intel/intel-linux-
firmware/raw/main/tgl_guc_65.4.0.bin

$wget
https://git.kernel.org/pub/scm/linux/kernel/git/firmware/linux-
firmware.git/plain/i915/tgl_huc_7.9.3.bin

$wget
https://git.kernel.org/pub/scm/linux/kernel/git/firmware/linux-
firmware.git/plain/i915/tgl_dmc_ver2_12.bin

$sudo cp *.bin /lib/firmware/i915

$sudo update-initramfs -u -k all
```

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

```
$ sudo vi /etc/default/grub
```



```
GRUB_CMDLINE_LINUX_DEFAULT="quiet splash i915.force_probe=* i915.enable_guc=2"
GRUB_CMDLINE_LINUX=""
```

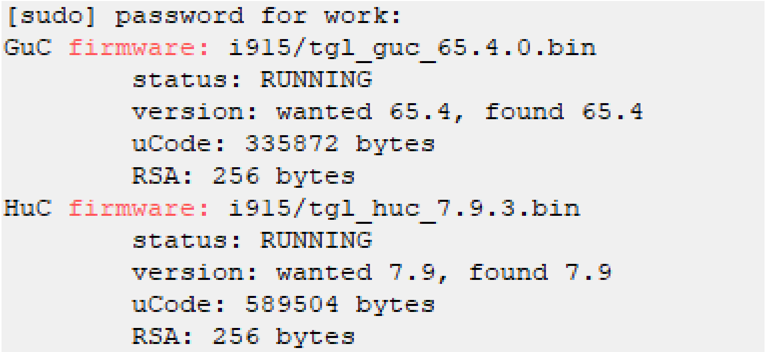
```
$ sudo -E update-grub
```

After restarting, use below commands to confirm the kernel upgrade and GPU firmware.

If there is Linux kernel version newer than v5.10.90 in the system, you need to manually select v5.10.90 kernel in Grub menu during boot.

If v5.10.90 is the latest Linux kernel version in the system, after restarting, it will be booted automatically. You can check the Linux kernel version using command `uname -a`.

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

$sudo cat /sys/kernel/debug/dri/0/i915_gpu_info | grep
firmware: -A 5   #Confirm Guc & Huc firmware installed
correctly
```



```
[sudo] password for work:
GuC firmware: i915/tgl_guc_65.4.0.bin
        status: RUNNING
        version: wanted 65.4, found 65.4
        uCode: 335872 bytes
        RSA: 256 bytes
HuC firmware: i915/tgl_huc_7.9.3.bin
        status: RUNNING
        version: wanted 7.9, found 7.9
        uCode: 589504 bytes
        RSA: 256 bytes
```

1.2.2 Upgrade Linux Kernel for 12th Generation Intel® Alder Lake processors

For 12th Generation Intel® Alder Lake processors, Linux kernel upgrade is mandatory. You can follow below instructions to upgrade Linux kernel version to 5.17 and install huc & guc firmware.

```
$mkdir kernel5.17
$cd kernel5.17

wget https://kernel.ubuntu.com/~kernel-
ppa/mainline/v5.17.15/amd64/linux-image-unsigned-5.17.15-
051715-generic_5.17.15-051715.202206141358_amd64.deb

$wget https://kernel.ubuntu.com/~kernel-
ppa/mainline/v5.17.15/amd64/linux-modules-5.17.15-051715-
generic_5.17.15-051715.202206141358_amd64.deb

$sudo dpkg -i *.deb

$wget
https://git.kernel.org/pub/scm/linux/kernel/git/firmware/linux-
firmware.git/plain/i915/tgl_guc_62.0.0.bin
$wget
https://git.kernel.org/pub/scm/linux/kernel/git/firmware/linux-
firmware.git/plain/i915/tgl_huc_7.9.3.bin
$wget
https://git.kernel.org/pub/scm/linux/kernel/git/firmware/linux-
firmware.git/plain/i915/adls_dmc_ver2_01.bin
$sudo cp *.bin /lib/firmware/i915/

$sudo update-initramfs -u -k all
```

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

```
$ sudo vi /etc/default/grub
```

```
GRUB_CMDLINE_LINUX_DEFAULT="quiet splash i915.force_probe=* i915.enable_guc=2"
GRUB_CMDLINE_LINUX=""

$ sudo -E update-grub
```

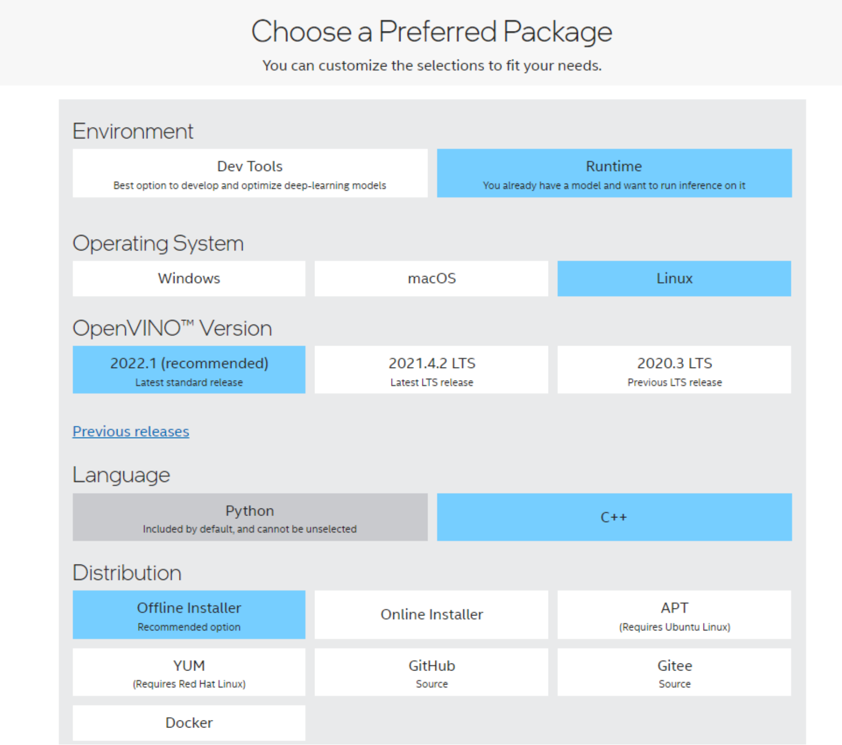
After restarting, use below commands to confirm the kernel version is correct

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

1.2.3 Download OpenVINO™ 2022.1 Linux Release

The sample application **video_e2e_sample** depends on OpenVINO™ libraries. It is suggested that the user installs OpenVINO™ 2022.1 Linux package from https://software.intel.com/en-us/openvino-toolkit.

Use either Edge, Chrome, Safari or Firefox browser to open the above URL. Select the Linux 22.1 **runtime offline package** like below:



Choose a Preferred Package

You can customize the selections to fit your needs.

Environment
- Dev Tools — Best option to develop and optimize deep-learning models
- Runtime — You already have a model and want to run inference on it

Operating System
- Windows
- macOS
- Linux

OpenVINO™ Version
- 2022.1 (recommended) — Latest standard release
- 2021.4.2 LTS — Latest LTS release
- 2020.3 LTS — Previous LTS release

Previous releases

Language
- Python — Included by default, and cannot be unselected
- C++

Distribution
- Offline Installer — Recommended option
- Online Installer
- APT (Requires Ubuntu Linux)
- YUM (Requires Red Hat Linux)
- GitHub Source
- Gitee Source
- Docker

Next, you may need to provide registry information if you are not signing in with your Intel account.

Note: Make sure that version **2022.1** is selected. Otherwise, downloading other version may cause SVET compiling or runtime error.

1.2.4 Install OpenVINO™

Use below command to install OpenVINO:

```
$sudo ./l_openvino_toolkit_p_2022.1.0.643_offline.sh
```

By default, it will be installed to /opt/intel/openvino_2022

The installation will take few minutes to complete. Run below command and also add to *~/.bashrc*. This command runs the OpenVINO™ environment variables setting up script. SVET build the scripts depending on these environment variables.

```
$ source /opt/intel/openvino_2022/setupvars.sh
```

1.2.5 Install NEO driver

Use below commands to install NEO driver 22.20.23198 from https://github.com/intel/compute-runtime/releases/tag/22.20.23198

```
$mkdir neo; cd neo
$wget https://github.com/intel/intel-graphics-
compiler/releases/download/igc-1.0.11222/intel-igc-
core_1.0.11222_amd64.deb
$wget https://github.com/intel/intel-graphics-
compiler/releases/download/igc-1.0.11222/intel-igc-
opencl_1.0.11222_amd64.deb
$wget https://github.com/intel/compute-
runtime/releases/download/22.20.23198/intel-level-zero-gpu-
dbgsym_1.3.23198_amd64.ddeb
$wget https://github.com/intel/compute-
runtime/releases/download/22.20.23198/intel-level-zero-
gpu_1.3.23198_amd64.deb
$wget https://github.com/intel/compute-
runtime/releases/download/22.20.23198/intel-opencl-icd-
dbgsym_22.20.23198_amd64.ddeb
$wget https://github.com/intel/compute-
runtime/releases/download/22.20.23198/intel-opencl-
icd_22.20.23198_amd64.deb
$wget https://github.com/intel/compute-
runtime/releases/download/22.20.23198/libigdgmm12_22.1.2_amd64.
deb

$sudo dpkg -i *.deb
```

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
```

Try to uninstall *intel-igc-opencl* and *intel-igc-core* manually with below commands:

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

Then add current user to the video group.

```
$sudo usermod -a -G video $USER
$sudo usermod -a -G render $USER
```

Then logout and login again to make the sure the user has been added to group “video” and “render”.

1.2.6 Install OpenCV

Follow below instructions to install OpenCV to /opt/intel/openvino_2022/extras/

```
$su
$cd /opt/intel/openvino_2022/extras/scripts/
$wget
https://storage.openvinotoolkit.org/repositories/openvino/packa
ges/2022.1/opencv/openvino_opencv_ubuntu20.tgz
$mv openvino_opencv_ubuntu20.tgz ../../
$cd ../../
$tar zxvf openvino_opencv_ubuntu20.tgz
```

1.3 Build concurrent video analytic sample application and dependent libraries

Download the source code from https://github.com/intel-iot-devkit/concurrent-video-analytic-pipeline-optimization-sample-l/tree/svet_onevpl. Note, it’s on branch **svet_onevpl.** The master branch contains the old version of sample application which is based on MediaSDK.

Run the *build_and_install.sh* script with below commands:

```
$git clone -b svet_onevpl 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.
   ************************************************************
   Enter the sudo password to proceed

[sudo] password for userxxx:
```

This will install dependent libraries, download and build libva, libva-util, gmm-lib, media-driver, onevpl and onevpl_gpu. It can take 10 to 20 minutes that depends your network bandwidth. It will ask password for `sudo` command. Enter the `sudo` password to continue the installation.

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.

Table 1. Steps in build_and_install.sh

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, onevpl and onevpl_gpu.	Source code libva, libva-util, gmm-lib, media-driver, onevpl and onevpl_gpu are downloaded into currently directory.
	Build and install libva, libva-util, gmm-lib, media-driver	Build and install libva and media-driver libraries to /opt/intel/svet/msdk successfully.
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
Add libva and Media SDK environment variable setting commands to current bash.		vainfo can run successfully:

	$ source ./svet_env_setup.sh $ /opt/intel/svet/msdk/bin/vainfo

1.4 Verify sample application's dependency

If *build_and_install.sh* and *source ./svet_env_setup.sh* run successfully, now run */opt/intel/svet/msdk/bin/vainfo* and you will see below output:

```
$ source svet_env_setup.sh

$ vainfo
error: can't connect to X server!
libva info: VA-API version 1.14.0
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_14
libva info: va_openDriver() returns 0
vainfo: VA-API version: 1.14 (libva 2.14.0)
vainfo: Driver version: Intel iHD driver for Intel(R) Gen
Graphics - 22.3.1 (99906da)
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
……
```

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

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

If there is any missing library, it means the installation was not completed. Contact your account manager from Intel and provide the output from the above command.

1.5 Prepare the video clips for testing

There are two AVC clips for testing under the video folder. If you want to use mp4 video clips, you can use bellow command to extract the element stream from MP4 file:

```
$sudo apt install ffmpeg

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

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

2.0 Run sample application video_e2e_sample

2.1 Check environment variables

Before running sample application, make sure the environment variables are set correctly in the current bash.

Run below command to check whether the OpenVINO™ environment is set:

```
$echo $INTEL_OPENVINO_DIR

/opt/intel/openvino_2022
```

If `$INTEL_OPENVINO_DIR` is empty, run below command to set OpenVINO™ environment.

```
$source /opt/intel/openvino_2022/setupvars.sh
```

Run below command to set the msdk environment variables in current bash:

```
$source ./svet_env_setup.sh
```

2.2 Modify the video path in parameter file

The *build_and_install.sh* downloads two test video clips to the video folder. If you want to use your own test clip, you can modify the video path (following `-i::h264`) of **every line** in example par files under *par_file/inference/n16_1080p_face_detect_30fps.par*. See the text in the red box below.

```
-i::h264 ./video/1080p.h264 -join -hw -async 4 -dec_postproc  -
o::sink -vpp_comp_dst_x 480 -vpp_comp_dst_y 540 -vpp_comp_dst_w
480 -vpp_comp_dst_h 270 -ext_allocator -infer::fd ./model -fps
30
```

Otherwise you will see below error message when running the sample application:

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

2.3 Enable cl_cache

The loading of inference models can take a long time. It is 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, 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 are active VNC sessions, close them first. The **-p** option is to keep the current user environment variables settings.

IMPORTANT NOTICE: Run *source ./svet_env_setup.sh* first when you start a new bash (or change user in bash such as run **su -p**) to run *./bin/video_e2e_sample*

If you want to run *video_e2_sample* with normal user or with X11 display, you can replace *-rdrm-DisplayPort* with *-rx11*. See *par_file/inference/n16_face_detection_1080p_x11.par* for inference.

Note: X11 rendering is not 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 of par files for several typical use cases. Refer to Chapter 2.5 for the detailed information of parameters in par files.

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

If you have not run the following command to the Libva and OneVPL environment variables for your current bash, run it before running **video_e2e_sample** application.

Command line to set the Libva and OneVPL environment variables:

```
#source ./svet_env_setup.sh
```

Command line to run the **video_e2e_sample** application:

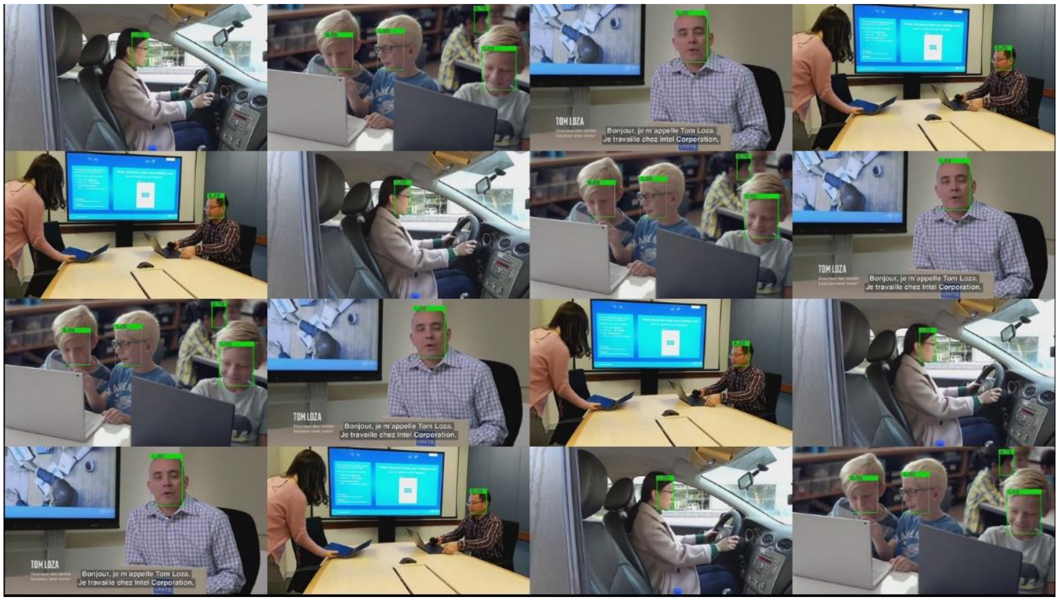
```
#./bin/video_e2e_sample -par
par_file/inference/n16_face_detection_1080p.par -stat 100
```

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. "-stat 100" means print average time cost of one frame every 100 frames. The output in terminal looks like below:

```
Input=4;Framerate=-
1.000;Total=1978.842;Samples=100;StdDev=6.758;Min=13.203;Max=38
.773;Avg=19.788
Input=13;Framerate=-
1.000;Total=1979.877;Samples=100;StdDev=6.923;Min=12.927;Max=37
.636;Avg=19.799
```

"Avg=19.788" means for input stream 4, average time cost of processing one frame is 19.788ms which is 1000 / 19.788 = 50.5fps.

The first loading of face detection models to GPU is slow and you are required to wait for a minute until the video showing on the display as depicted in the following image. With **cl_cache** enabled, the next running of face detection models will be much faster.


TOM LOZA
Bonjour, je m'appelle Tom Loza.
Je travaille chez Intel Corporation.

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 the par files.

By default, the pipeline is running as fast as it can. If you want to limit the FPS to a certain number, add `–fps FPS_number` to every decoding sessions, which start with `–i` in the par files. Refer to *par_file/inference/ n16_1080p_face_detect_30fps.par*.

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

If you have not run the following command to set the Libva and OneVPL environment variables for your current bash, run it before running the **video_e2e_sample** application.

Command line to set the Libva and OneVPL environment variables:

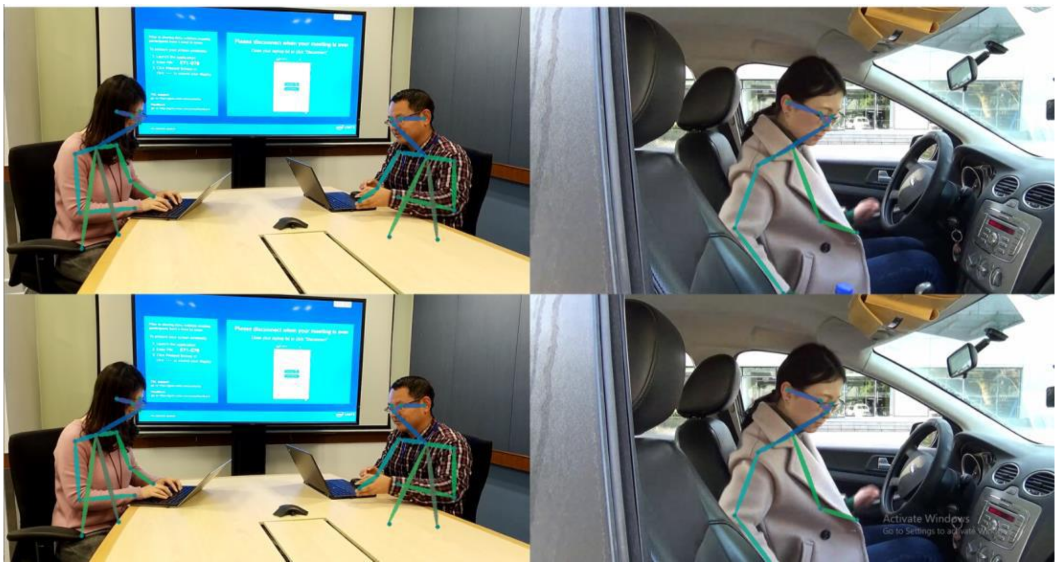
```
./source svet_env_setup.sh
```

Command line to run the **video_e2e_sample** application:

```
./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 is the image of this demo.



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

If you have not run the following command to set the Libva and OneVPL environment variables for your current bash, run it before running the **video_e2e_sample** application.

Command line to set the Libva and OneVPL environment variables:

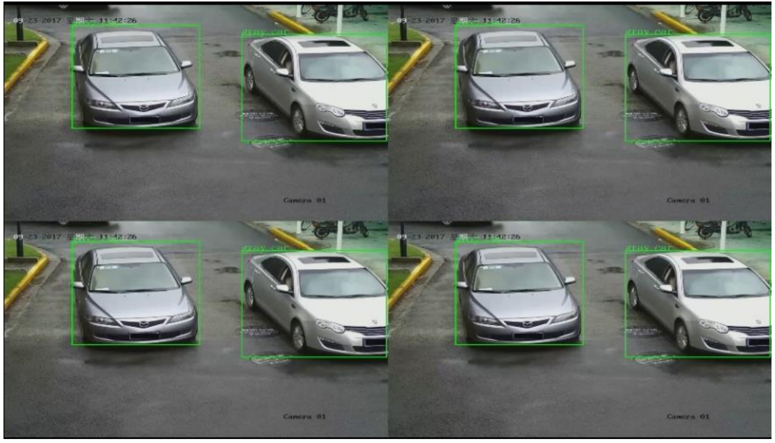
```
./source svet_env_setup.sh
```

Command line to run the **video_e2e_sample** application:

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

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

Below is the image of this demo.



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

If you have not run the following command to set the Libva and OneVPL environment variables for your current bash, run it before running the **video_e2e_sample** application.

Command line to set the Libva and OneVPL environment variables:

```
./source svet_env_setup.sh
```

Command line to run the **video_e2e_sample** application:

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

To use RTSP video stream instead of a local video file, you can modify the par file and use RTSP URL to replace the 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 4-channel video decoding, multi objects detection/tracking, composition, and display

If you have not run the following command to set the Libva and OneVPL environment variables for your current bash, run it before running the **video_e2e_sample** application.

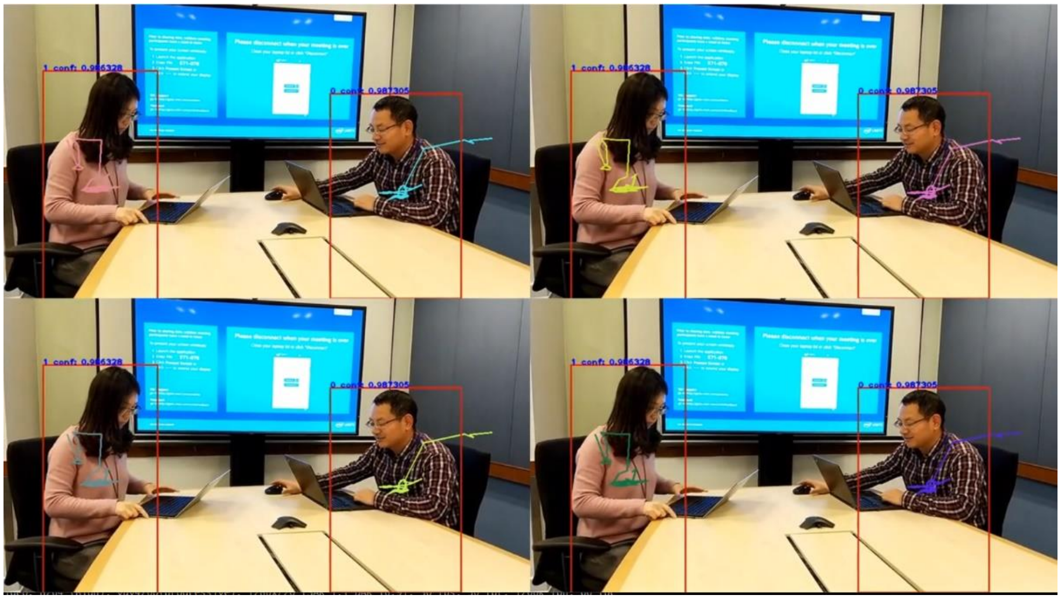
Command line to set the Libva and OneVPL environment variables:

```
./source svet_env_setup.sh
```

Command line to run the **video_e2e_sample** application:

```
./bin/video_e2e_sample -par
par_file/inference/n4_multi_object_tracker.par
```

The object detection and motion tracking inference are specified by `–infer::mot ./model` in the par file. `./model` is the directory that stores objects detection and motion tracking models IR files.



2.4.6 2-Channel Video Decoding, Yolov3 Detection, Composition and Display

To convert Yolov3 model, you can refer to https://docs.openvinotoolkit.org/latest/openvino_docs_MO_DG_prepare_model_convert_model_tf_specific_Convert_YOLO_From_Tensorflow.html.

If you have not run the following command to set the Libva and OneVPL environment variables for your current bash, run it before running the **video_e2e_sample** application.

Command line to set the Libva and OneVPL environment variables:

```
#./source svet_env_setup.sh
```

You can edit *par_file/inference/n2_yolo_h264.par* and replace *yolofp16/yolo_v3.xml* with the yolov3 IR file path in your system.

Command line to run the **video_e2e_sample** application:

```
#./bin/video_e2e_sample -par par_file/inference/n2_yolo_h264.par
```

2.4.7 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.

2.4.8 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.

2.4.9 16-channel RTSP video decoding, RTSP stream storing, face detection, composition, encode, and display

If you have not run the following command to set the Libva and OneVPL environment variables for your current bash, run it before running the **video_e2e_sample** application.

Command line to set the Libva and OneVPL environment variables:

```
#./source svet_env_setup.sh
```

Command line to run the **video_e2e_sample** application:

```
#./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.

2.4.10 2-channel RTSP stream storing

If you have not run the following command to set the Libva and OneVPL environment variables for your current bash, run it before running the **video_e2e_sample** application.

Command line to set the Libva and OneVPL environment variables:

```
$./source svet_env_setup.sh
```

Command line to run the **video_e2e_sample** application:

```
$./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.

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
```

2.4.11 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.

If the two par files specify different resolutions for display, for example, 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.

If you have not run the following command to set the Libva and OneVPL environment variables for your current bash, run it before running the **video_e2e_sample** application.

Command line to set the Libva and OneVPL environment variables:

```
#./source svet_env_setup.sh
```

Command line to run the **video_e2e_sample** application:

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

2.4.12 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. 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**.

2.4.13 Use VPP instead of SFC in decoding session

User can set to use VPP (Accelerated by Execution Unit in Intel Graphics) instead of SFC(Scale and format conversion HW function in VDBox) for scaling and color format convert in video decoding sessions. Modify the par file to replace “-dec_postproc” with “-dc::rgb4”, then VPP will be used. In most cases, SFC gets better performance.

2.4.14 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 CPU` to specify CPU as target device.

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

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.
Refer to example par file *n1_infer_options.par*.

2.4.15 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*.

2.4.16 MCU mode

MCU stands for Multiple Controller Unit. In MCU mode, SVET sample application can be used to test multiple channel video decoding, video composition and video encoding at the same time.

For example, below command can be used to test 8 1080p AVC decode, 8 1080p composition and 8 1080p AVC encoding workload:

```
$./source svet_env_setup.sh

$./bin/video_e2e_sample -par mcu1_1080p_4to4.par
mcu2_1080p_4to4.par -stat 100
```

2.4.17 Run concurrent video analytic sample application without OpenVINO™

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

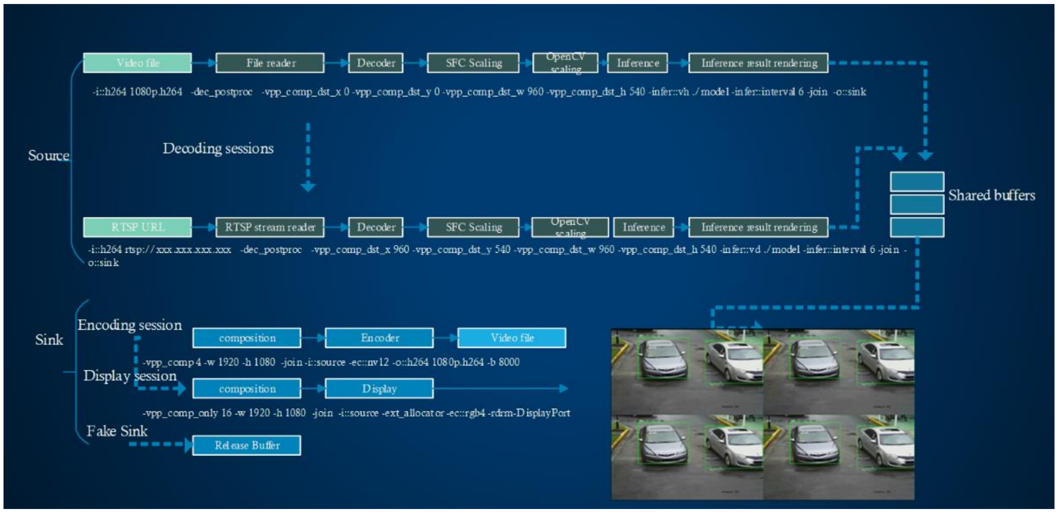
The build command is shown as below:

```
$./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.

2.5 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.



```
-i::h264 1080p.h264  -dec_postproc  -vpp_comp_dst_x 0 -vpp_comp_dst_y 0 -vpp_comp_dst_w 960 -vpp_comp_dst_h 540 -infer::vh ./model -infer::interval 6 -join  -o::sink
```

```
-i::h264 rtsp://xxx.xxx.xxx.xxx  -dec_postproc  -vpp_comp_dst_x 960 -vpp_comp_dst_y 540 -vpp_comp_dst_w 960 -vpp_comp_dst_h 540 -infer::vd ./model -infer::interval 6 -join -
o::sink
```

```
-vpp_comp 4 -w 1920 -h 1080  -join -i::source -ec::nv12 -o::h264 1080p.h264 -b 8000
```

```
-vpp_comp_only 16 -w 1920 -h 1080  -join  -i::source -ext_allocator -ec::rgb4 -rdrm-DisplayPort
```

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:mot ./model →multi objects tracking -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. 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. **Note:** "-o" option must be used together with this option, but it won't generate any output file.

-infer::device <GPU, CPU>	Indicate the inference target device. 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. 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. 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

Table 2. Parameters Used in Example Par Files

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. Switch Ubuntu* to text mode(Ctrl + Alt + F3) and root user by command “su -p” before using this parameter.
-rx11	Using X11 as display. Make sure environment variable DISPLAY set correctly if run the sample application remotely in a console terminal.

2.6 Frequently Asked Questions

Q: Where can I find the description of options used in par file?

A: See chapter 2.5 in user guide

Running the SVET sample application with option "-?" can show the usage of options.

Q: Why does the system need to be switched to text console mode before running the sample application?

A: The sample application uses libDRM to render the video directly to display, so it needs to act as master of the DRM display, which isn't allowed when X client is running. If there is any VNC session, close it. Because VNC session also starts X client.

If the par file doesn't include display session, there is no need to switch to text mode.

Q: Why does "su -p" is required to switch to root user before running the sample application?

A: To become DRM master, it needs root privileges. With option "-p", it will preserve environment variables, like LIBVA_DRIVERS_PATH, LIBVA_DRIVER_NAME and LD_LIBRARY_PATH. If without "-p", these environment variables will be reset and the sample application will run into problems.

Q: Is it possible to use X11 instead of DRM display?

A: If user doesn't want to switch to text console mode or switch to root for using DRM display, user can replace "-rdrm-DisplayPort" with "-rx11" in the par file. However, the X11 rendering isn't as effcient as DRM rendering. According to our 16-channel face detection 1080p test on CFL , the time cost of each frame increased by around 6ms. Example [par file](./par_file/inference/n16_face_detection_1080p_x11.par) using X11 as rendering method.

Q: Is there any limitation of the order of decoding, encoding and dislay sessions in the par file?

A: Yes. The decoding sessions must be descripted firstly. If there is display dession, it must be the last line in par file.

Q: The loading time of 16-channel face detection demo is too long.

A: Make sure **cl_cache** is enabled by command `echo $cl_cache_dir`. If this environment is not set, enable **cl_cache** by running command `export cl_cache_dir=/tmp/cl_cache` and `mkdir -p /tmp/cl_cache`. Then after the first running of 16-channel face detection demo, the compiled OpenCL kernles are cached and the model loading time of next running of 16-channel face detection demo will only take about 10 seconds.

More details about **cl_cache** can be found at https://github.com/intel/compute-runtime/blob/master/opencl/doc/FAQ.md

Q: Can source numbers for `-vpp_comp_only` or `-vpp_comp` be different from number of decoding sessions?

A: No. The source numbers for `-vpp_comp_only` or `-vpp_comp` must be equal to the numer of decoding sessions. Otherwise, the sample application will fail during pipeline initialization or running.

Q: How to limit the fps of whole pipeline to 30?

A: Add `-fps 30` to every decoding session.

Q: Why does `-fps 30` not working with `-fake_sink`?

A: Fake sink session does not support `-fps 30`. Add `-fps 30` to every decoding session instead.

Q: How to limit the frame number of inputs to 1000?

A: Add `-n 1000` to every decoding dessions. But do not add `-n` to encode, display and fake sink session. These sink sessions will automatically stop when the source session stops. Note, this option is not working if both `-vpp_comp_only` and `-vpp_comp` are set.

Q: Where can I find information for the models?

A: Refer to https://github.com/opencv/open_model_zoo/tree/master/models/intel. The names of models used in sample application are

- face-detection-retail-0004
- human-pose-estimation-0001

- vehicle-attributes-recognition-barrier-0039
- vehicle-license-plate-detection-barrier-0106

Q: Can I use other OpenVINO™ version other than 2022.1?

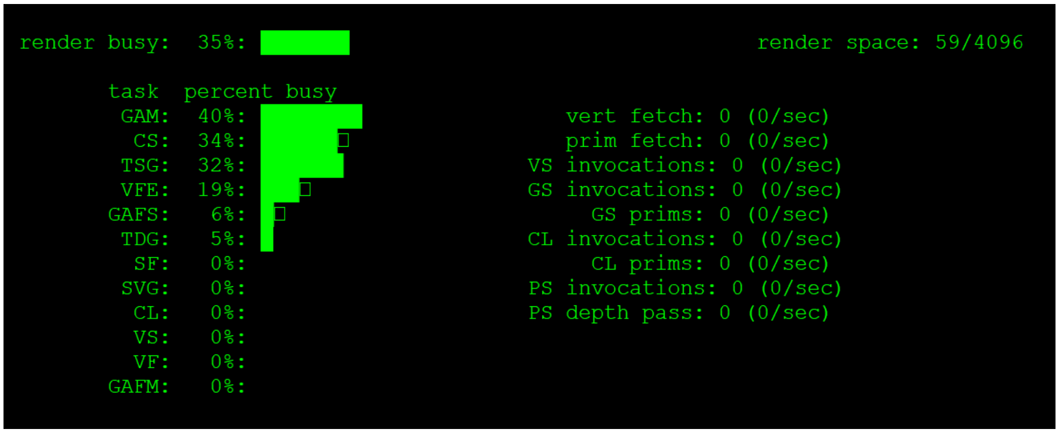
A: Yes, but you must modify some code due to changing interfaces. And also you need to download the IR files and copy them **to ./model manually**. Refer to *script/download_and_copy_models.sh* for how to download the IR files.

3.0 Monitor overall GPU resource usage statistics

There are some tools can be used to view GPU resource usage statistics. Refer to chapter 3.1.4 white paper CDI#621636 for additional info.

3.1 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.



```
render busy:  35%:                                        render space: 59/4096

       task  percent busy
        GAM:  40%:                            vert fetch: 0 (0/sec)
         CS:  34%:                            prim fetch: 0 (0/sec)
        TSG:  32%:                         VS invocations: 0 (0/sec)
        VFE:  19%:                         GS invocations: 0 (0/sec)
       GAFS:   6%:                              GS prims: 0 (0/sec)
        TDG:   5%:                         CL invocations: 0 (0/sec)
         SF:   0%:                              CL prims: 0 (0/sec)
        SVG:   0%:                         PS invocations: 0 (0/sec)
         CL:   0%:                         PS depth pass: 0 (0/sec)
         VS:   0%:
         VF:   0%:
       GAFM:   0%:
```