

## Cross Compiling Ubuntu Kernel & Prophesee device drivers

Detail Document - 02 for Kria-App

### Ubuntu Kernel Corss Compilation Steps:

This document is on how to cross-compile ubuntu kernel in Host PC. For updating the Prophesee camera driver and camera operation inside Kria-Ubuntu, we have to re-build the Kria-Ubuntu kernel with the necessary support for custom camera driver.

Steps for cross compiling linux kernel from source as mentioned here:

[Rebuilding+the+Certified+Ubuntu+for+Xilinx+Devices+20.04+LTS+Kernel+from+Source](#)

Above link is used for `Ubuntu 20.04 LTS`: focal , which was changed to `jammy` corresponding to `Ubuntu 22.04`

So terminal command used:

```
echo "deb-src http://archive.ubuntu.com/ubuntu jammy main" | sudo tee -a
/etc/apt/sources.list.d/jammy.list

sudo apt-get update

sudo apt-get build-dep linux

sudo apt-get install git fakeroot libncurses-dev gcc-aarch64-linux-gnu
linux-tools-common

git clone
https://git.launchpad.net/~canonical-kernel/ubuntu/+source/linux-xilinx-zyn
qmp/+git/jammy
```

This will create `jammy` folder containing linux kernel source code..

Next selected the kernel branch as currently running in kria board:

```
cd jammy

git tag
```

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```
git checkout Ubuntu-xilinx-zynqmp-5.15.0-1027.31
```

```
export ARCH=arm64
export $(dpkg-architecture -aarm64)
export CROSS_COMPILE=aarch64-linux-gnu-
```

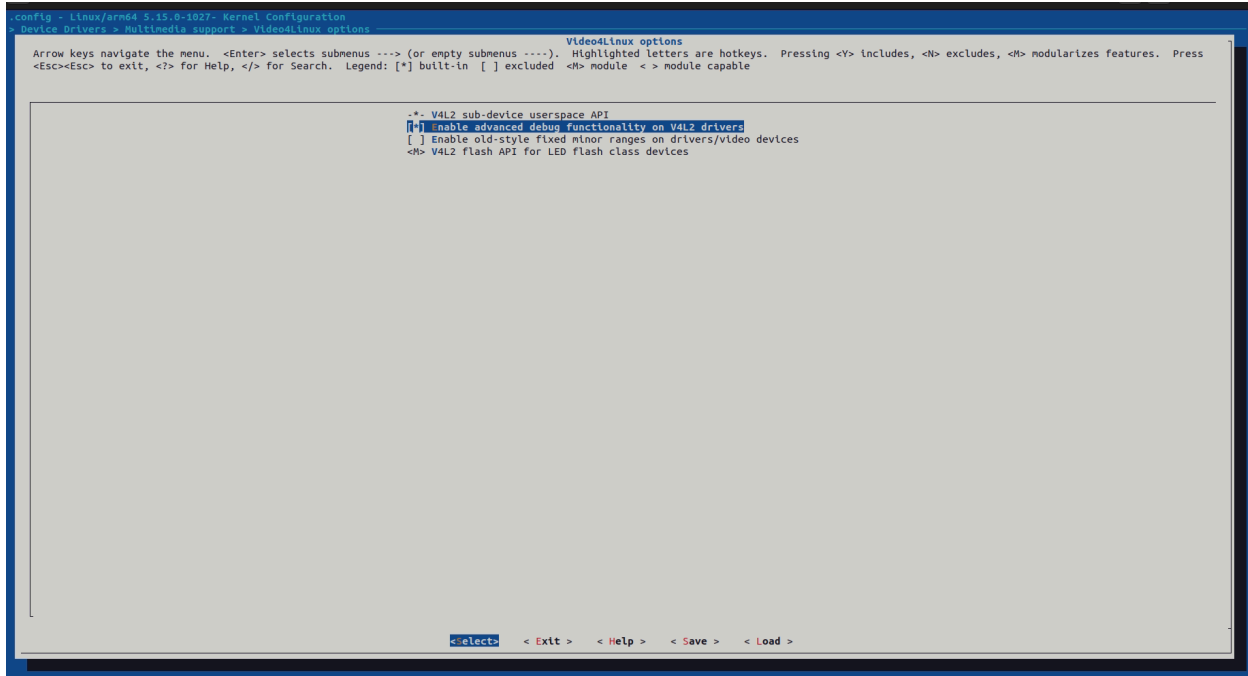
Next configure the kernel by running following commands:

```
...
```

```
fakeroot debian/rules clean
fakeroot debian/rules editconfigs do_enforce_all=false
...
```

Update the cross compiled linux kernel with CONFIG\_VIDEO\_ADV\_DEBUG config enabled:

```
Symbol: VIDEO_ADV_DEBUG [=y]
Type : bool
Defined at drivers/media/v4l2-core/Kconfig:28
Prompt: Enable advanced debug functionality on V4L2 drivers
Depends on: MEDIA_SUPPORT [=y]
Visible if: MEDIA_SUPPORT [=y] && VIDEO_DEV [=y]
Location:
  -> Device Drivers
    -> Multimedia support (MEDIA_SUPPORT [=y])
(2)    -> Video4Linux options
```



...

```
fakeroot debian/rules clean
fakeroot debian/rules binary
...
```

Note:

Error during build:

...

mkdir

```
/home/logictronix03/ubuntu_workspace/jammy_custom/jammy/debian/linux-libc-dev/usr/include/
aarch64-linux-gnu
```

mkdir: cannot create directory

```
'/home/logictronix03/ubuntu_workspace/jammy_custom/jammy/debian/linux-libc-dev/usr/include/
aarch64-linux-gnu': File exists
```

make: \*\*\* [debian/rules.d/2-binary-arch.mk:569: install-arch-headers] Error 1

...

Soln:

Remove the aarch64-linux-gnu directory using rm -rf command:

...

rm -rf

```
/home/logictronix03/ubuntu_workspace/jammy_custom/jammy/debian/linux-libc-dev/usr/include/
aarch64-linux-gnu
```

...

After build is complete \*.deb files are found outside ubuntu kernel folder `jammy` folder:

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```
logictronix03@logictronix03:~/ubuntu_workspace/jammy_custom$ ls *.deb
linux-buildinfo-5.15.0-1027-xilinx-zynqmp_5.15.0-1027.31_arm64.deb  linux-modules-5.15.0-1027-xilinx-zynqmp_5.15.0-1027.31_arm64.deb  linux-xilinx-zynqmp-tools-host_5.15.0-1027.31_all.deb
linux-headers-5.15.0-1027-xilinx-zynqmp_5.15.0-1027.31_arm64.deb  linux-xilinx-zynqmp-headers-5.15.0-1027.31_all.deb
linux-image-5.15.0-1027-xilinx-zynqmp_5.15.0-1027.31_arm64.deb    linux-xilinx-zynqmp-tools-common_5.15.0-1027.31_all.deb
logictronix03@logictronix03:~/ubuntu_workspace/jammy_custom$
```

Also kernel build directory is found at : `jammy/debian/build/build-xilinx-zynqmp/` which is needed to cross compile the device drivers.

After build is completed, copy the \*.deb file to Kria target board.

Install the kernel files by running following command:

'''

```
sudo dpkg -i *.deb
```

'''

Then reboot the system:

'''

```
sudo reboot
```

'''

## Cross Compiling Prophesee device drivers:

Prophesee device driver consist of following drivers:

- Prophesee ccam5 sensor driver:
  - Sensor driver repository : <https://github.com/prophesee-ai/linux-sensor-drivers>
- Prophesee video drivers
  - for processing event data from sensor and v4l2 compatible video device.
  - Video driver repository : <https://github.com/prophesee-ai/zynq-video-drivers>

Get the drivers using git commands:

```
git clone https://github.com/prophesee-ai/linux-sensor-drivers
git clone https://github.com/prophesee-ai/zynq-video-drivers
```

First setup the KERNEL\_SRC and arm64 environment variable to linux kernel build directory:

```
export KERNEL_SRC=<path of
workspace>/jammy/debian/build/build-xilinx-zynqmp/
export ARCH=arm64
export $(dpkg-architecture -aarm64)
export CROSS_COMPILE=aarch64-linux-gnu-
```

Building Prophesee device drivers:

```
cd linux-sensor-drivers
make
```

Here is the log of the device driver build:

```
logictronix03@logictronix03:~/ubuntu_workspace/linux-sensor-drivers$ make
make -C /home/logictronix03/ubuntu_workspace/jammy_custom/jammy/debian/build/build-xilinx-zynqmp/ M=/home/logictronix03/ubuntu_workspace/linux-sensor-drivers
make[1]: Entering directory '/home/logictronix03/ubuntu_workspace/jammy_custom/jammy/debian/build/build-xilinx-zynqmp'
CC [M] /home/logictronix03/ubuntu_workspace/linux-sensor-drivers/lmx636.o
MODPOST /home/logictronix03/ubuntu_workspace/linux-sensor-drivers/Module.symvers
CC [M] /home/logictronix03/ubuntu_workspace/linux-sensor-drivers/lmx636.mod.o
LD [M] /home/logictronix03/ubuntu_workspace/linux-sensor-drivers/lmx636.ko
BTF [M] /home/logictronix03/ubuntu_workspace/linux-sensor-drivers/lmx636.ko
make[1]: Leaving directory '/home/logictronix03/ubuntu_workspace/jammy_custom/jammy/debian/build/build-xilinx-zynqmp'
logictronix03@logictronix03:~/ubuntu_workspace/linux-sensor-drivers$ ls
COPYING  lm636.c  lm636.ko  lm636.mod  lm636.mod.c  lm636.mod.o  lm636.o  Makefile  modules.order  Module.symvers  psee-format.h  sony,lm636.yaml
logictronix03@logictronix03:~/ubuntu_workspace/linux-sensor-drivers$
```

Above build creates kernel driver : `lm636.ko`

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Next building video drivers:

```
...
```

```
cd zynq-video-driver
```

```
make
```

```
...
```

Above build fails with undeclared media bus type error:

```
logictronix@logictronix03: /ubuntu_workspace/zynq-video-driver$ make
make -C /home/logictronix03/ubuntu_workspace/jammy_custom/jammy/debian/build/build-xilinx-zynqmp/ M=/home/logictronix03/ubuntu_workspace/zynq-video-drivers
make[1]: Entering directory /home/logictronix03/ubuntu_workspace/jammy_custom/jammy/debian/build/build-xilinx-zynqmp/
CC [M] /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-dma.o
CC [M] /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-composite.o
/home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-composite.c:66:1: warning: 'psee_graph_find_entity_from_media' defined but not used [-Wunused-function]
66 | psee_graph_find_entity_from_media(struct psee_composite_device *pdev,
    | ^
LD [M] /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-video.o
CC [M] /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-csi2rxss.o
CC [M] /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-streamer.o
CC [M] /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-tkeep-handler.o
/home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-tkeep-handler.c: In function 'set_format':
/home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-tkeep-handler.c:164:42: error: 'MEDIA_BUS_FMT_PSEE_EVT21ME' undeclared (first use in this function); did you mean 'MEDIA_BUS_FMT_PPEG_1X8'?
164 |         if ((fmt->format.code == MEDIA_BUS_FMT_PSEE_EVT21ME) &&
            |                                     ^
            |                                     MEDIA_BUS_FMT_PPEG_1X8
/home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-tkeep-handler.c:164:42: note: each undeclared identifier is reported only once for each function it appears in
/home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-tkeep-handler.c:167:40: error: 'MEDIA_BUS_FMT_PSEE_EVT21' undeclared (first use in this function); did you mean 'MEDIA_BUS_FMT_V12_1X12'?
167 |         format->code = MEDIA_BUS_FMT_PSEE_EVT21;
            |                                ^
            |                                MEDIA_BUS_FMT_V12_1X12
make[2]: *** [/home/logictronix03/ubuntu_workspace/jammy_custom/jammy/scripts/Makefile.build:297: /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-tkeep-handler.o] Error 1
make[1]: *** [/home/logictronix03/ubuntu_workspace/jammy_custom/jammy/Makefile:1911: /home/logictronix03/ubuntu_workspace/zynq-video-drivers] Error 2
make[1]: Leaving directory /home/logictronix03/ubuntu_workspace/jammy_custom/jammy/debian/build/build-xilinx-zynqmp/
make: *** [Makefile:7: all] Error 2
logictronix@logictronix03: /ubuntu_workspace/zynq-video-driver$
```

It can be solved by adding `psee-format.h` header in `psee-tkeep-handler.c` file:

```
* Copyright (C) Prophesee S.A.
*/

#include <linux/device.h>
#include <linux/module.h>
#include <linux/of.h>
#include <linux/platform_device.h>
#include <linux/clock.h>

#include <media/v4l2-async.h>
#include <media/v4l2-subdev.h>

#include "psee-format.h"

#define PAD_SINK 0
#define PAD_SOURCE 1

#define REG_VERSION (0x0)

#define REG_CONTROL (0x4)
#define BIT_ENABLE BIT(0)
#define BIT_BYPASS BIT(1)
#define BIT_CLEAR BIT(2)

#define REG_CONFIG (0x8)
```

Then running `make` command driver is compiled and build:

```
logictronix03@logictronix03: /ubuntu_workspace/zynq-video-drivers$ make
make -C /home/logictronix03/ubuntu_workspace/jammy_custom/jammy/debian/build/build-xilinx-zynqmp/ M=/home/logictronix03/ubuntu_workspace/zynq-video-drivers
make[1]: Entering directory '/home/logictronix03/ubuntu_workspace/jammy_custom/jammy/debian/build/build-xilinx-zynqmp'
CC [M] /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-tkeep-handler.o
MODPOST /home/logictronix03/ubuntu_workspace/zynq-video-drivers/Module.symvers
CC [M] /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-csi2rxss.mod.o
LD [M] /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-csi2rxss.ko
BTF [M] /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-csi2rxss.ko
CC [M] /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-streamer.mod.o
LD [M] /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-streamer.ko
BTF [M] /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-streamer.ko
CC [M] /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-tkeep-handler.mod.o
LD [M] /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-tkeep-handler.ko
BTF [M] /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-tkeep-handler.ko
CC [M] /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-video.mod.o
LD [M] /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-video.ko
BTF [M] /home/logictronix03/ubuntu_workspace/zynq-video-drivers/psee-video.ko
make[1]: Leaving directory '/home/logictronix03/ubuntu_workspace/jammy_custom/jammy/debian/build/build-xilinx-zynqmp'
logictronix03@logictronix03: /ubuntu_workspace/zynq-video-drivers$ ls *.ko
psee-csi2rxss.ko  psee-streamer.ko  psee-tkeep-handler.ko  psee-video.ko
logictronix03@logictronix03: /ubuntu_workspace/zynq-video-drivers$
```

After Prophesee Video driver build, following linux driver modules are created:

- psee-csi2rxss.ko
- psee-streamer.ko
- psee-tkeep-handler.ko
- psee-video.ko

To use the Prophesee drivers, copy all the \*.ko file to Kria Ubuntu /lib/modules/5.15.0-1027-xilinx-zynqmp/ folder.