

Summer Student 2019 Project Report

CARIBOU DAQ: OS UPDATE AND SoC BOARD UPGRADE

CLICdp WG Vertex & Tracking Detector
Technology meeting, August 2nd 2019



Reyhan Ramadhan (EP-LCD)
Institut Teknologi Bandung, Indonesia
Supervisors: Tomas Vanat, Jens Kroeger

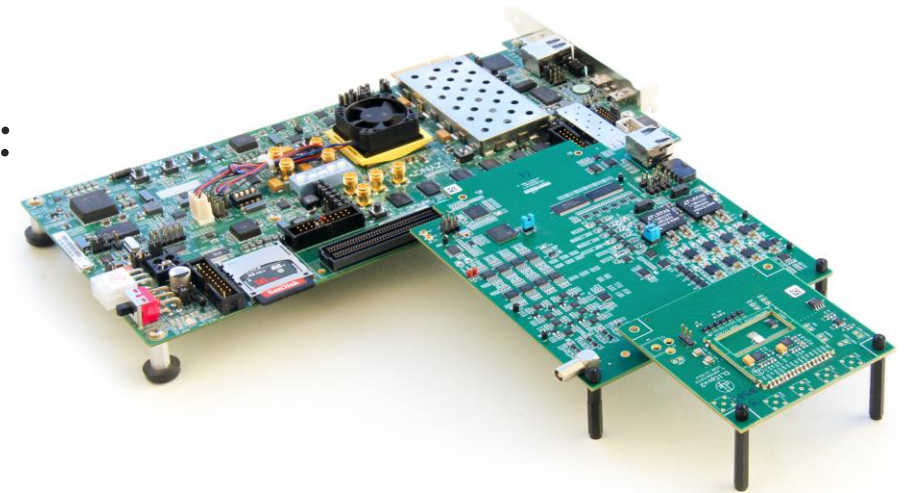
OUTLINE

- Introduction to CaRIBOu
- Part 1: OS & Software Update
 - Motivation & objectives
 - Update process
 - Verification
- Part 2: Upgrade of SoC Board
 - Motivation & objectives
 - Project structure
 - Dev & build process
 - Results
- Conclusion & Future Works



INTRODUCTION TO CARIBOU

- CaRIBOU: versatile data acquisition system to facilitate pixel detector R&D.
- Based on Xilinx Zynq-7000 ZC706 Eval. Kit
- Runs (modified) Poky embedded Linux distro. by the Yocto Project.
- Currently on version Rocko (2.4.4)
- Additional functionality through ‘layers’:
meta-caribou
 - Linux tools and packages.
 - FPGA firmware.
 - Peary DAQ software.



PART I: OS & SOFTWARE UPDATE

Motivation

- Poky version Rocko no longer supported.



Objectives

- Update Poky to version Thud (2.6.2, latest supported by Xilinx).
 - ...along with all associated layers (OpenEmbedded, Xilinx, Caribou).
- Refresh/fix kernel patches to suit any changes from Rocko to Thud.
- Test updated OS & patches with ATLASPix & CLICpix2 configuration.

PROCESS: “BLIND” UPDATE

- Update to Thud and build the image without modifying anything else.
- Expected problems:
 - Kernel patches don't work → kernel files were changed.
 - Peary doesn't work → I2C header file removed/modified in previous Poky update.
- Unexpected problems:
 - prepare_sd script fails → image boot directory structure changed, not enough sleep.

PROCESS: CHANGED FILES

- `conf/machine/caribou-zynq7.conf`
 - Boot image directory structure.
- *[Peary]* `peary/interfaces/I2C/i2c.cpp`
 - New (or rather, old) header file.
- Kernel patches redone on new kernel.
 - Usually they only differ in line number (i.e. other stuff were added or removed in the update).
 - More significant change: `drivers/i2c/i2c-core.c` split into `/drivers/i2c/i2c-core-base.c` and several other files.
- Add sleep (delay) action before & after SD card mounting/unmounting.

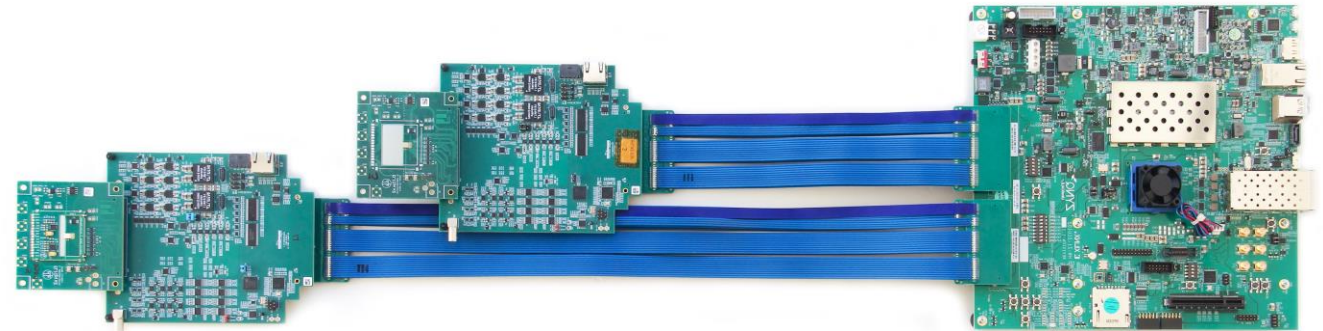
VERIFICATION

- Verification using a standard ATLASPix setup.
 - Tests I2C functionality and data acquisition.
 - Initialization, configuration, and trial DAQ run.
- Verification using a standard CLICpix2 setup.
 - Tests both I2C and SPI functionality.
 - Initialization, configuration, and trial DAQ run.
- System manages to work in both cases; updated system verified.

PART 2: UPGRADE OF SoC BOARD

Motivation

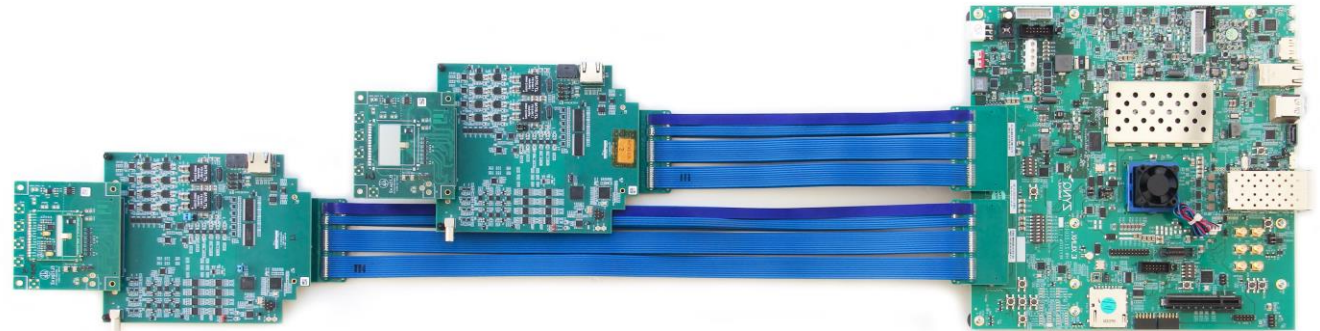
- Modern architecture (UltraScale+), better support.
- More computing power (ARM Cortex-A53 64-bit quad-core proc).
- Can connect 2 boards.
- ZCUI02 and UltraScale+ architecture more widely used at CERN.
- All for the same price!



PART 2: UPGRADE OF SoC BOARD

Objectives

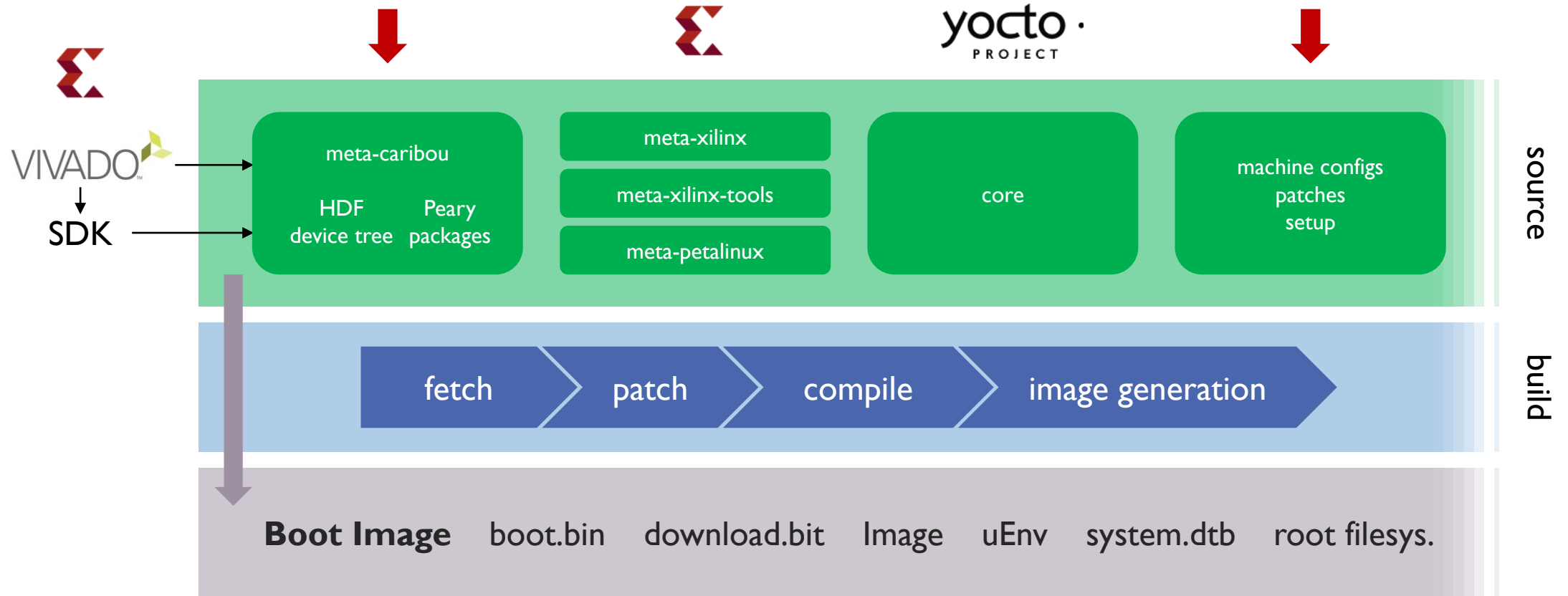
- Build embedded Linux project suitable for ZCUI02 board (derived from Yocto/Xilinx reference repo).
- Migrate Peary, firmware (Vivado design) as appropriate.
- Add CaRIBOu-specific mods (Peary, firmware, packages through meta-caribou).
- Validate on board.



DEV & BUILD PROCESS

- Uses Yocto layers and project setup supported by Xilinx.
- FPGA firmware developed in Vivado.
- CaRIBOu modifications and Peary added through meta-caribou.
- Build system (bitbake) wraps everything up and generates image.

DEV & BUILD PROCESS



RESULTS

- Full Linux boot image with meta-caribou modification, Peary, and a 'hello world' firmware.
- Verification with bare ZCUI02 board (not connected to any detector).

Results

- Boot up successful, with a catch.
 - Ethernet problems (currently slows down boot up).
- Firmware verified.
 - Runs an LED program as set up in the block design.
- Peary runs, but memory addresses weren't set up properly yet.
 - Setup both in firmware (block design) and Peary (hardcoded addresses).

CONCLUSION

- Successfully updated old CaRIBOu system to the latest OS version, with packages and kernel patches fixed.
 - Update process will be documented in written report for future references.
- Successfully build working boot image (Linux) for new ZCUI02 board.
- Verified that meta-caribou functionality works and Peary runs on the new board.
- Firmware (i.e. FPGA part) not yet migrated.

FUTURE WORKS

- Firmware (i.e. FPGA part) not yet migrated, so new board cannot interface with detectors yet.
 - Update IP cores, memory addressing.
 - Peary has to be migrated as well.
 - Modify hardcoded memory address according to FPGA block design.
- Development and build process will be documented in written report to help with this process.

EXTRA NOTES

- UltraScale+ architecture on ZCUI02 board has various features that may (or may not) be interesting for future developments.
 - RPU, GPU, ...
- There are plans in the Xilinx community to consolidate Xilinx-supported layers.
 - Currently a mess of several layers: meta-xilinx-bsp, meta-xilinx-contrib, meta-xilinx-standalone, meta-xilinx-tools, possibly meta-petalinux).
 - Better? More confusing? Both?