TULIPP

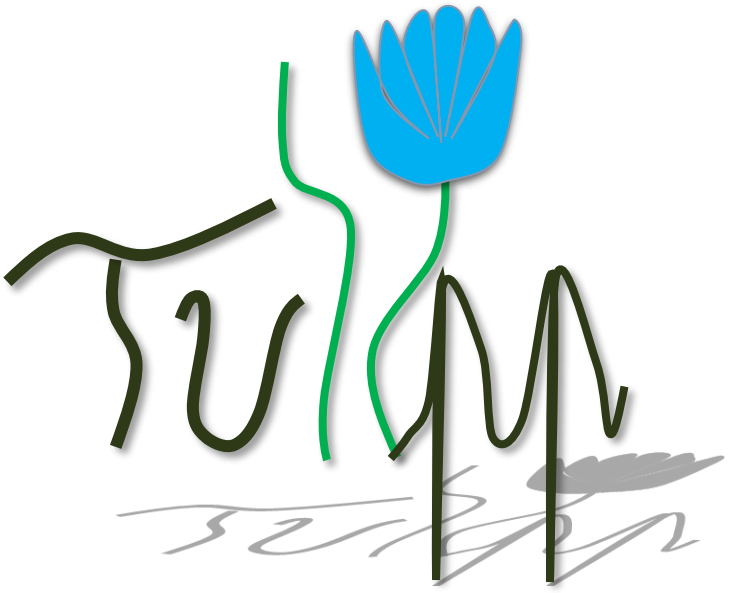
H2020-ICT-O4-2015

Grant Agreement n° 688403

Project title:

Towards Ubiquitous Low-power Image Processing Platforms

Public Interim Executive Summary



Period covered by the report:

From 01/02/2016 [M1] - 31/07/2017 [M18]

Document Description

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Contents

1. SUMMARY OF THE CONTEXT AND OVERALL OBJECTIVES OF THE PROJECT

Image processing is the domain dealing with image manipulation, transformation and analyse. This domain takes two-dimensional data as an input which width, height and pixel depth depend on the sensor. The wide variety of sensors and application types makes image processing a complex and deep domain.

The development of power-efficient solutions gives new embedded products the ability to analyse images brings more intelligence to embedded systems. It is a key to more and better services, quality, self-adaptation, autonomy.

This will allow cars to driver safer, medical devices to assist surgeons, drones will get the ability to fly on their own and seek out for people to be rescued.

To achieve energy-efficient products, it is necessary to work on the whole platform (hardware, libraries and tool-chain). Each layer must be aware of the consequences on the other layers of any choice made. We shaped a common holistic view of the system called the reference platform, supported by the an open-source and purposed designed hardware, called: *"TULIPP Starter Kit"*, alias "*TSK*"

Key Performance Indicators will be measured to demonstrate the gain we get during the project to ensure that we improved the efficiency of the processing.

TULIPP will deliver the "*TSK"*, consisting of the platform instance, project applications, and reference platform handbook. The aim of the "*TSK"* is to provide engineers with a generic evaluation platform that serves as a base for productively developing low power image processing applications.

• **Objective 1**: Define a reference platform for low-power image processing applications
• **Objective 2:** Instantiate the reference platform through use cases applications
• **Objective 3:** Demonstrate and plan improvements of defined key performance indicators
• **Objective 4:** Start and manage an ecosystem of stakeholders to extend image processing norms

2. WORK PERFORMED FOR PERIOD [M1-M18] AND MAIN RESULTS ACHIEVED SO FAR

2.1 THE REFERENCE PLATFORM

Designers and implementers always face the same questions and problems. We came up with the definition of a reference platform being the collection of such guidelines and recommendations. During this period, together with the reference platform concept, we defined how to build the guidelines.

2.2 THE HARDWARE PLATFORM

We selected a set of chips based on our first idea that System on Chips (SoCs) offer General Purpose Processors (GPPs) as well as domain specific accelerators and / or programmable logic that can implement application's functions into hardware.

We have evaluated the candidates and chosen the Zynq UltraScale+ chip, the most versatile platform available with the best power-efficiency. Building a platform with this chip will allow us to combine heterogeneity with parallelism. Then we selected the interfaces required by our use cases and started to design a base board.

2.3 THE OPERATING SYSTEM

We implemented and instantiated the low-level parts of the RTOS. During this period, we considered only the Processing System of the Zynq SoC. The Zynq Programmable Logic is considered in the next period of the project.

Improvements were developed for power-efficiency, for support to standard APIs and libraries to ease application porting and implementation.

We organized an integration week with all the partners of the consortium. To learn about the operating system and start implementing the use cases. This RTOS version was also delivered to all the partners.

2.4 THE TOOL CHAIN

The basic TULIPP tool chain which development started during this period is a minimal end-to-end implementation that assists developers with the mapping of functionality to platform components. The tool chain will create the binaries and provide configuration rules to the operating system. The tool chain will also include rudimentary performance and energy profiling support.

During this first period of the project, we have focused on developing the software library with optimized, streaming-capable image processing functions for SDSoC.

2.5 USE CASES AND PLATFORM INSTANCE EVALUATOIN

The evaluation of the instance of the platform we made is based on three use cases (Automotive Driver Assisted System, Medical Imagery, and Unmanned Avionic Vehicle) which we described from a detailed technical perspective and started to implement on the reference platform.

Further to the KPI measurement, work was carried out on the use cases to port them on the TULIPP platform.

2.6 DISSEMINATION AND COMMUNICATION

We created a Poster and Brochure, a Press Release (English, French, German and Spanish) presented in 31 news media and added the TULIPP Website here http://tulipp.eu/tulipp-in-the-news/

We use WebEx for weekly meetings and designed internal and external communication channels:

Forum	http://support.tulipp.eu
Github	https://github.com/tulipp-eu/
Slack	https://tulippeuproject.slack.com
Facebook	https://www.facebook.com/Tulipp-H2020-292082554458468/
Twitter	https://twitter.com/TULIPP_H2020
LinkedIn	https://www.linkedin.com/in/tulipp-eu-b4b108121/
YouTube	https://www.youtube.com/channel/UCnGD6o_ghcS98uwpCkhRpaA/featured
SlideShare	https://www.slideshare.net/TulippEu

We started an ecosystem of 22 members http://tulipp.eu/advisory-board-members/ and an advisory board with 3 members.

We participated in several conferences and exhibitions. http://tulipp.eu/publications/

We organized a joint workshop PEPGUM'17 in Sweden - http://tulipp.eu/pepgum-2017-workshop-at-hipeac/ - with four other European projects targeted at improving the power efficiency LPGPU2, SAFEPOWER, Hercules and Eyes of Things.

We presented at the following events:

EVA Summit 2016	http://goo.gl/aEHuaW
NMI Event	https://www.slideshare.net/TulippEu
EMVA Forum 2017	https://www.youtube.com/watch?v=il1WkksRdTg
Heidelberg Image Processing Forum 2017	https://www.youtube.com/watch?v=lojAn1oBHq0

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3. PROGRESS BEYOND THE STATE OF THE ART AND IMPACT

3.1 REFERENCE PLATFORM, INSTANCE AND VALIDATION

We introduced the definition of a handbook and starter kit. The two items together will be a collection of valuable knowledge on energy-efficient implementation of image processing platforms together with an implementation example. This result will be available to anyone that wants to try the result of the project. We believe that this is more valuable than our first ambition because it illustrates a real implementation that can be tried rather than strong rules that one must follow and should adopt.

We want to capitalize the knowledge and information collected and share it wider than just to people following the project evolution. We think we can achieve this by writing a book that can be used by anyone to understand better how to use hardware and optimize embedded applications dedicated to image processing. In order to improve the impact of the book we want to be shared chapters with projects having the same goals or application domains. Since the creation of a label was no longer possible, we believe that this is the best way to have a wide impact after the end of TULIPP.

The instance of the platform will be delivered to the Advisory Board members during a dedicated tutorial where they will learn how to use and benefit from the TULIPP platform. This platform instance with hardware, operating system and tool chain will also be available for customers and shipped as a bundle.

The validation of the platform will be performed through the implementation of our use cases on it.

3.2 DISSEMINATION AND COMMUNICATION

Additionally, the TULIPP project will be presented in a chapter of a Springer Book on energy-efficient servers, planned to be published in December 2017.

The next event will be the E3IPA workshop - https://www.hipeac.net/events/activities/7519/e3ipa/ - at the HIPEAC'18 conference in January that we share with other projects having the same interest in high energy-efficiency. During this workshop we will share the TULIPP book content and ask them to get involved in writing a chapter.

We will also follow the EMVA events and attend them when we can as it is an opened door to an ecosystem that is intrinsically interested in the topics covered by TULIPP.

Close to the end (December 2018) of the project we will organize a tutorial for the EcoSystem/Advisory Board, but not restricted to them. During this tutorial, we will explain the TULIPP project, the guidelines, the book and the platform instance we developed and which they can try. A *"TULIPP Starter Kit"* will also be distributed to the EcoSystem/Advisory Board at the end of this tutorial to allow the EcoSystem to grow after the project has finished.

4. IMAGES ATTACHED TO THE SUMMARY FOR PUBLICATION

Figure 1: TULIPP team during the kick-off in Paris, France

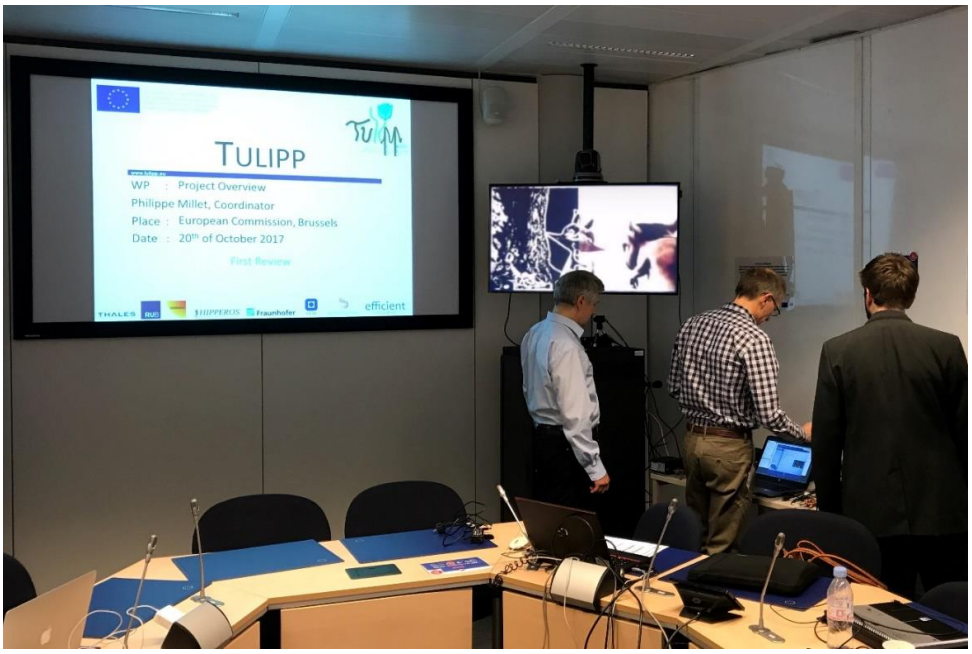

Figure 2: Getting the demos for the review meeting on 20th October 2017 going in Brussels, Belgium