appliance for their business or research needs, and benefit from the full support of the M2DC team of experts. The platform chassis was exhibited at major international events such as ISC High Performance, Teratec and SC18, where visitors were very enthusiastic about its PCIe-based switching technology, middleware concept, integration of field-programmable gate arrays (FPGAs) for HPC, and the heterogeneous nature of the server.

To find out more, visit the M2DC website or follow the project on social media.

m2dc.eu @M2DC_Project facebook.com/M2DCproject
linkedin.com/company/m2dc bit.ly/M2DC_YouTube

NAME: M2DC: Modular Microserver DataCentre
START/END DATE: 01/01/2016 – 30/06/2019

KEYWORDS: microserver, data centre, high-performance computing (HPC), heterogeneous architectures, modular, scalable
COORDINATOR: Ariel Oleksiak, Poznań Supercomputing and Networking Center (PSNC)
PARTNERS: **Poland**: Poznań Supercomputing and Networking Center (PSNC); **France**: Commissariat à l´énergie atomique et aux énergies alternatives (CEA), REFLEX CES, Alliance Services Plus; **Germany**: Christmann Informationstechnik + Medien, Huawei Technologies Düsseldorf, OFFIS, CEWE; **Italy**: Politecnico di Milano; **Slovenia**: XLAB; **Switzerland**: Vodafone Automotive Telematics; **UK**: Arm
BUDGET: approx. €8 million

M2DC has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 688201.

TULIPP: HIGH-PERFORMANCE IMAGE PROCESSING FOR EMBEDDED COMPUTERS

Towards Ubiquitous Low-power Image Processing Platforms

Question: What do advance driver assistance systems (ADAS), drones and medical X-ray imaging have in common? Answer: They all need high-performance image processing and have tight size, weight and power (SWaP) requirements. Thanks to TULIPP, there are powerful new tools to help them achieve this.

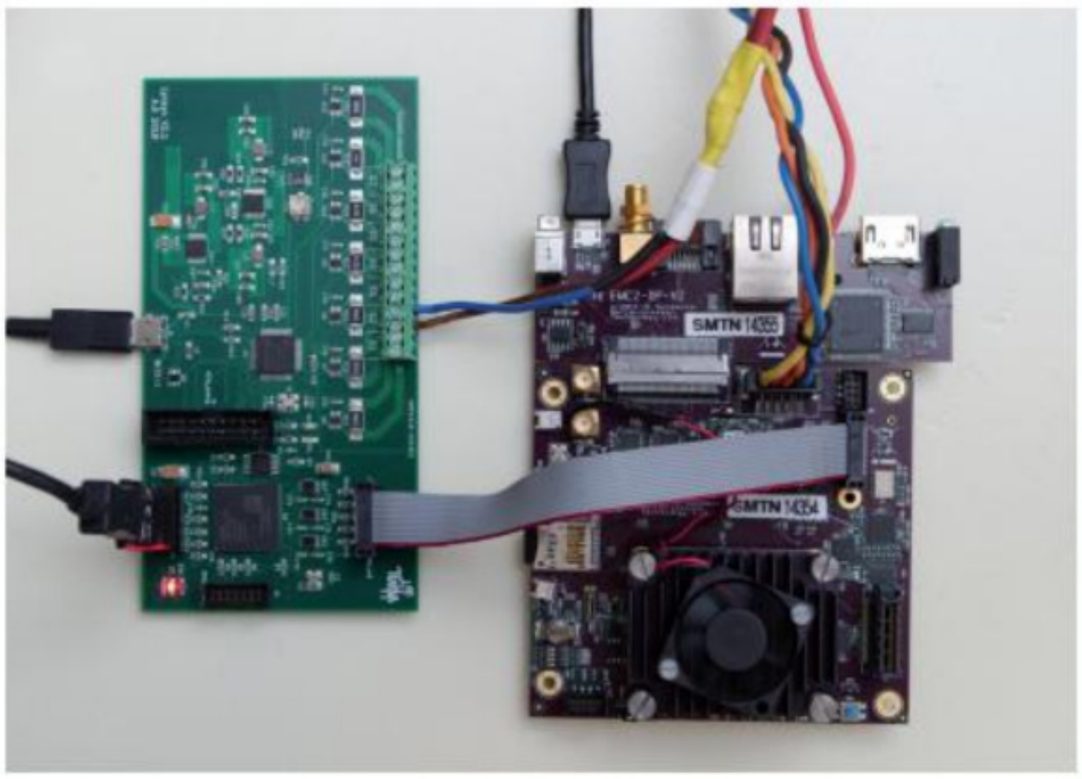
Coordinated by Thales, the three-year TULIPP project has designed a common reference processing platform – hardware, operating system and programming environment – capturing the real-time requirements, high-performance image processing and vision applications common to these three application domains. The project has also developed a set of guidelines to help select combinations of computing and communication resources to be instantiated in the platform while minimizing energy use and reducing both development costs and time-to-market.

TULIPP uses an abstraction known as the generic development process (GDP) to capture image processing application development. The input to this is a functionally correct implementation of the image processing system that runs on a desktop computer, before the application is moved to the embedded platform. GDP is an iterative process where each iteration is designed to bring the image processing system closer to system requirements. TULIPP aimed to minimize the number of iterations through the GDP and create a framework that efficiently supports developers carrying out the GDP.

To future-proof the reference platform, TULIPP has documented the design process in a book which will form the basis for future standardization efforts. The project has also created a development kit consisting of:

- a TULIPP hardware platform developed by Sundance, based on the Xilinx Zynq multi-processor systems on chip (MPSoCs) Ultrascale+™
- the TULIPP operating system, based on the HipperOS multi-core operating system
- STHEM, the TULIPP toolchain, which was designed by NTNU, the Norwegian University of Science and Technology, and TU Dresden

This development kit is available as a bundle and is available for purchase from Sundance.



It has been applied to three compelling use cases:

- **Medical use case** focusing on mobile C-arms, a medical system that displays X-ray views from inside a patient's body, greatly enhancing the surgeon's ability to perform surgery. By bringing the compute power of a personal computer to the hardware the size of a smartphone, TULIPP makes it possible to achieve the same image quality with a quarter of the radiation.

- **Unmanned aerial vehicles (UAVs)**: TULIPP developed a real-time obstacle avoidance system for UAVs, also known as drones, based on a stereo camera. Disparity maps from camera images are used to locate obstacles in the flight path and help steer the UAV around them.

- **Advanced driver assistance systems**: TULIPP worked on ways to improve pedestrian recognition in real time. Modern image processing algorithms are capable of extracting almost all the information required about the vehicle's surroundings, but there is often a big step between the prototypical implementation on a desktop PC and the integration into a small, energy-efficient electronic control unit (ECU). TULIPP's optimizations, using FPGA logic in combination with Arm cores, resulted in processing time of 66ms per frame.

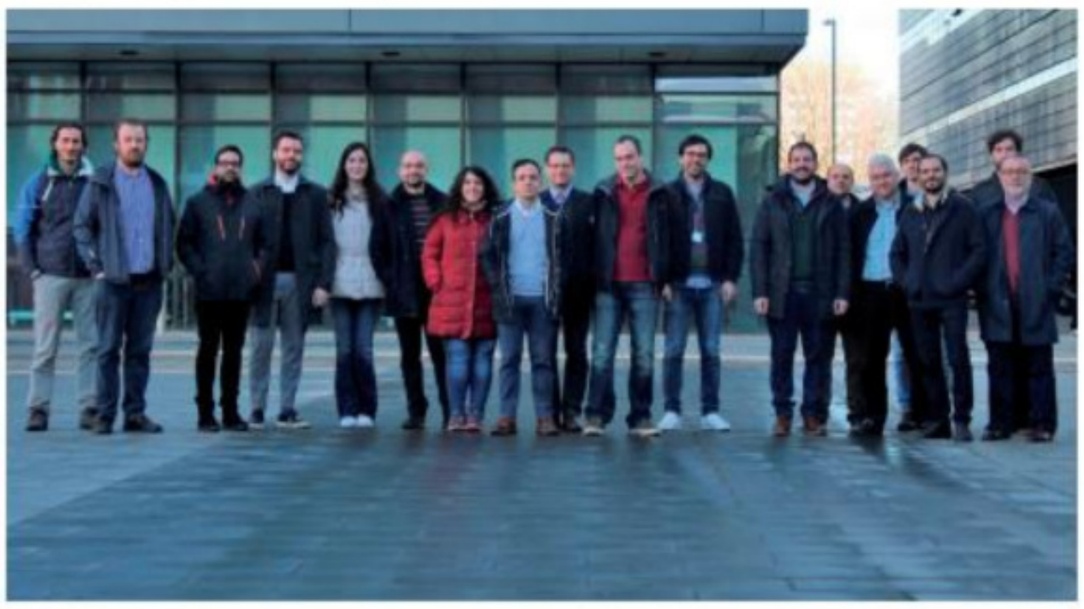
As it reaches its close, TULIPP is working on bringing more intelligence to the platform by adding new accelerated technology dedicated to artificial neural networks.

NAME: TULIPP: Towards Ubiquitous Low-power Image Processing Platforms
START/END DATE: 01/02/2016 – 31/01/2019
KEYWORDS: microserver, data centre, high-performance computing (HPC), heterogeneous architectures, modular, scalable
COORDINATOR: Philippe Millet, Thales
PARTNERS: **Belgium**: HipperOS; **France**: Thales, Efficient Innovation; **Germany**: Ruhr-Universität Bochum, Technische Universität Dresden, Fraunhofer-Gesellschaft; **Norway**: Norges Teknisk-Naturvitenskapelige Universitet (NTNU); **Sweden**: Synective Labs; **UK**: Sundance Multiprocessor Technology.
BUDGET: €4.73 million

TULIPP has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 688403.

SOFTWARE FOR THE BIG DATA ERA WITH E2DATA

To address pressing scalability concerns, both big data users and cloud infrastructure providers such as Google, Microsoft, Amazon and Alibaba are investing in heterogeneous hardware resources. Combining a variety of architectures including central processing units (CPUs), graphics processing units (GPUs), field-programmable gate arrays (FPGAs) and manycore processors, the aim is to increase performance while minimizing climbing operational costs. In parallel, large companies are developing their own in-house application-specific integrated circuits (ASICs), with Google's TensorFlow being the prime example.



E2Data is a new European project that will provide a new big data software paradigm to deliver maximum resource utilization for heterogeneous cloud deployments without requiring changes to the original source code. The proposed solution takes a cross-layer approach, allowing vertical communication between the four key layers of big data deployments (application, big data software, scheduler / cloud provider and execution runtime). E2Data dynamically exploits heterogeneous hardware – in this case GPUs and FPGAs – by:

- enabling dynamic heterogeneous compilation of arbitrary code
- following a full-stack vertical approach where state-of-the-art software frameworks will be enhanced
- designing an intelligent, elastic system where we can:
  - profile results, communicate to task and data schedulers and assess decisions to improve performance and energy efficiency
  - fall back and recompile on the fly to handle possible failures

To achieve its ambitious goals, the E2Data consortium brings together two different kinds of big data practitioner. On the one hand, big data users from the finance, healthcare, green building