TEACHING NEWSLETTER

NO 4

OCTOBER 2021

TEACHING is an EU-funded project that designs a computing platform and the associated software toolkit supporting the development and deployment of autonomous, adaptive, and dependable CPSoS applications, allowing them to exploit sustainable human feedback to drive, optimize and personalize the provisioning of their services.

This issue provides a grasp of the main project developments in the period of April 2021 - October 2021. It also provides facts on the results achieved, as well as links to the latest project publications, webinars, events, etc.

During the reference project period TEACHING has progressed considerably and hit the 2nd milestone named "Demo of the integrated TEACHING core technology reported in D1.2, D2.2, D3.2, D4.2 and D5.2". We are very pleased to register this progress which gives credit to hard work of the TEACHING partners and provides motivation for reaching the next milestones. Now, we are getting ready to demonstrate these results during the upcoming Interim Technical Review Meeting to be held in mid-October 2021.

Milestone #2 Achieved

WHAT HAS BEEN DONE?

Based on the previously defined plan, within the scope of WP1, HUA together with UNIPI has organized two integration meetings to implement a TEACHING platform MVP. The integration meetings were also opportunities for the TEACHING partners to physically meet, though partially. HUA also developed a demo based on a mockup federated learning scenario showing how the architecture is finally taking shape, with the core functionalities of sensing, quantifying, integrating and programming being fully manifested in the latest designs. Furthermore, UNIPI has taken care of connecting the AI models from the AIaaS toolkit with the communication and computing functionalities of the HPC2I toolkit. In this respect, CNR leveraged its consortium role and competencies by focusing on the interoperation between the AIaaS toolkit and the overall geographically distributed, multilayer platform integrating Cloud resources and heterogeneous Edge layers. A demo setup has been produced, capable of streaming sensor data from wearable devices to the computing platform which executes the AI models processing the sensors data to compute a stress estimate. Finally, TUG was active in terms of architecture design, as well as supporting the separation and individual alignment of dependability factors.

In the scope of WP2, CNR coordinated the research and development effort of the components forming a high-level, distributed software architecture that supports the TEACHING platform geographical distribution. CNR contributed to the design and development of key platform components providing networking, that are based on a publish-subscribe layer exploiting the Kafka protocol and were integrated in the overall demonstrators of the project. The team is now performing R&D activity aimed at optimizing latency and bandwidth usage of the networking support. The CNR team also selected a set of technologies that allow to effectively perform service deployment and lifecycle management on all platform layers (Near/Far Edge and Clouds). UNIPI has released the WindFlow library version 3.0 on GitHub. The library provides a new run-time system for stream processing on small multicores and co-processors, able to take advantage of data parallelism provided by GPUs (leveraging the physically shared memory with CPU) and pipeline parallelism on reconfigurable hardware. Support for the execution of workloads on FPGA cards is currently under development and testing and will be released as part of the forthcoming WindFlow version. The unit is also building a use case leveraging WindFlow in a federated learning scenario on automotive-road device networks, where the library offers support to handle efficient processing of traffic data on the road-side units.

During the examined period, Infineon built a data-gathering platform that is also supposed to act as a test environment for AI algorithms, adversarial attacks, and their defenses. The platform includes a RC-car equipped with a single board computer, controlling the actuators as well as multiple sensors; among all is also an Infineon radar sensor monitoring the car's environment. Running the vehicle by the output of these AI algorithms is currently in a testing phase. Also, the implementation of hardware accelerators on which the AI algorithms can be run in silicon on the edge device are currently investigated. Furthermore, the Flight Management System application (led by TRT) has been ported to the final iMx8 board provided by I&M, with a Linux OS. Two hardware sensor frameworks have been ported to the same target board: METrICS and THErM. METrICS collects the software behavior on the hardware in terms of timing and hardware resource usage. THERM collects temperature, energy, current and power information. These two frameworks are now collecting time-series in the form of CSV traces that will be used in the context of WP4 to understand the expected software behavior on the hardware and detect potential threats as deviation from this expected behavior.

WP3 has released D3.2 at the recent TEACHING milestone. This deliverable enhanced the knowledge base of the TEACHING project WP3 activities and provided an outline of activities that targeted the dependability engineering approaches of the TEACHING project partners. The key activities involve safety and security focused concepts and design patterns for AI-based systems in mission-critical applications. Some aspects of this work were presented at the EuroPloP21, SafeComp21, and EuroSPI2021 conferences to the related expert communities and have been published via Wiley, J.UCS, and Springer Journals. Furthermore, WP3 disseminated findings of the respective tasks to the other work packages and disseminated knowledge bricks of the TEACHING project in different university lectures and industrial working groups. With the aim to analyze in a structured way the dependable CPSoS solution within TEACHING, Marelli is developing a procedure for Functional Safety Assessment based on both ISO26262 and SOTIF standards. First steps in this direction have been taken: an item definition template has been shared with partners, to collect proper information on the system under safety analysis. Marelli's interest is also related to cyber security, and for this reason a first workshop about cybersecurity contents in the TEACHING architecture has been performed

involving the consortium and in particular the companies and universities with high expertise in cybersecurity. Marelli internal activity in Regulatory fields allows the consortium to be informed about novelties in the Regulations and standards about AI, cybersecurity and safety. In addition, UNIPI has been collaborating with Marelli to develop an approach that allows to measure and assess robustness of recurrent neural networks for sequential data processing. These metrics have been integrated into a safety-assessment framework compatible with automotive standards of functional safety certification. The work has been documented in a scientific publication which is going to be presented at a conference in December 2021.

The WP4 activities also progressed during the last months. UNIPI, in cooperation with the other partners HUA, CNR, Marelli, ITML, I&M, led the detailed design of the AIaaS Toolkit API starting from the objectives and the system architecture design articulated in the previous semester. UNIPI also led the main development of the AI-Toolkit mock-up prototype that, based on such APIs, constituted the base for a DEMO application in the context of driver stress monitoring for driving style personalization. HUA continued its experiments by applying various policy-based Reinforcement Learning techniques (like the Actor-Critic RL algorithm) to automatically select the best driving mode during driving. All experiments have initially been conducted in the Carla simulation environment and have consequently been employed to train the RL model. Further integration of the trained model to the TEACHING framework allowed stress measurements on real users to be used as input for inference and consequently to dynamically adjust the driving mode of a simulated vehicle based on the actual stress indicator of an actual human. Under this scope, joint works among different TEACHING tasks were conducted to integrate the current results of the driving mode personalization task with the findings of the human state recognition task and the results of this work has produced a joint demo that showcases the interactions of these two tasks. Apart from jointly contributing to the definition of the AIaaS Toolkit API, CNR provided implementation and support for the local and global communication needs of the AIaaS instances. A Kafka-MQTT bridge component is part of the AIaaS architecture. Together with Cloud-deployed Kafka Services, the bridge allows interoperation among several AIaaS instances deployed over Edge and Cloud resources, for the sake of supporting federated learning processes via a pub/sub network. Those advances and results contributed to the newly released D4.2 report and demonstrator, as well as to scientific papers. Moreover, Marelli proposed requirements for AI dependable systems design. Based on the state of the art for dependability for AI and DNN, a study for the definition of some attributes and their possible evaluation metrics, to describe a dependable AI-based system, has been done.

WP5 has reached the recent TEACHING milestone by releasing deliverable D5.2, providing an outline of activities that target the demonstration of the TEACHING technology in two industrial applications, avionics and autonomous driving at the interim stage of the project. The current activities are based around the integration of AI algorithms into the dependable hardware platform and further integration of the platform into controlled industrial environments. For the avionics use case, that implies correct behaviour of the safety-critical software on the target platform, which incorporates Flight Management System, HIDS / HUMS monitoring system, and the Cyber-BlackBox. In the case of automotive application, the platform is being integrated into a driving simulator to enable an anticipated study, which is aimed at improving understanding of the human perception of automated driving. The study will amalgamate previous research findings with the TEACHING developments. Some aspects of this work were

recently presented at the Euromicro DSD/SEAA 2021 conference in Palermo and published in IEEE explore ("Measuring trust in automated driving using a multi-level approach to human factors").

TEACHING DISSEMINATION and COMMUNICATION

During the reference period, the partners have intensively disseminated the project results by spreading knowledge and creating good networking opportunities with industrial and scientific peers. The TEACHING partners have focused to widen up the network of scientific experts of the project and transferred valuable scientific results by participating in multiple online conferences and workshops. In this regard, CNR was involved in creating and maintaining links with other projects (ACCORDION, CHARITY) as well as with relevant scientific and technological networks (HIPEAC). CNR dissemination activities include events like the FRAME workshop (collocated with HPDC 2021) and participation in conferences like GECON 21. TUG was involved in creating links with DRIVES and OpenInnoTrain projects. It was active in scientific dissemination at EuroPloP, SafeComp, and EuroSPI conferences and created a knowledge transfer link with CyberEng project for cybersecurity engineering methods development. TUGs interdisciplinary discourse with domain experts from Tier1 and VDA/intacs raised awareness for the TEACHING project and its outcomes. TUG was able to discuss and share cybersecurity related approaches with automotive partners outside the consortium. Additionally, interactions with IEEE Working Group on SW Safety and the Austrian ISO Country-coordinator have been established. Visibility of the project and transferability of the project outcomes has been promoted through the generation of promotional material (blog post, videos, online podcast sessions) and by regular dissemination to the public through social media channels.

TEACHING PUBLICATIONS

The TEACHING project also had an active performance via journal and conference paper publication by presenting the research work carried out in the frame of the project. The list of the presented articles produced in the reference project period is shown below:

G. Mencagli, M. Torquati, A. Cardaci, A. Fais, L. Rinaldi, M. Danelutto, "WindFlow: High-Speed Continuous Stream Processing with Parallel Building Blocks," in IEEE Transactions on Parallel and Distributed Systems, vol. 32, no. 11 (doi: 10.1109/TPDS.2021.3073970)

M. Dzambic, J. Dobaj, M. Seidl, G. Macher, "AI Utilization Patterns for Dependable Systems" at European Conference on Pattern Languages of Programs (EuroPloP 2021), July 1-4, 2021

D. Bacciu, D. Di Sarli, C. Gallicchio, A. Micheli, N. Puccinelli, "Benchmarking Reservoir and Recurrent Neural Networks for Human State and Activity Recognition" International Work-Conference on Artificial Neural Networks (IWANN 2021), June 16-18, 2021.

C. Gallicchio, A. Micheli, L. Silvestri, 2021 "Phase Transition Adaptation" International Joint Conference on Neural Networks (IJCNN 2021), July 18-22, 2021

D. Bacciu, D. Di Sarli, P. Faraji, C. Gallicchio, A. Micheli. "Federated Reservoir Computing Neural Networks" International Joint Conference on Neural Networks (IJCNN 2021), July 18-22, 2021

D. Bacciu, S. Akarmazyan, E. Armengaud, et al., "TEACHING -Trustworthy autonomous cyber-physical applications through human-centred intelligence", Proceedings of the 2021 IEEE International Conference on Omni-layer Intelligent systems (IEEE COINS 2021), August 23-25, 2021

G. Macher, S. Akarmazyan, E. Armengaud, et al., "Dependable Integration Concepts for Human-Centric AI-based Systems" 40th International Conference on Computer Safety, Reliability and Security (SafeComp 2021) September 7-10, 2021

ESANN 2021

NEURAL NETWORKS

IEEE ITSC 2021

P. Clement, H. Danzinger, O. Veledar, C. Koenczoel, G. Macher, A. Eichberger "Measuring trust in automated driving using a multi-level approach to human factors" Euromicro Conference on Digital System Design 2021 - Special Session: Intelligent Transportation Systems (ITS), September 1-3, 2021

H. Kavalionak, E.Carlini, P. Dazzi, L. Ferrucci, M. Mordacchini, M. Coppola "Impact of Network Topology on the Convergence of Decentralized Federated Learning Systems", 26th IEEE Symposium on Computers and Communications (ISCC 2021). Athens, Greece, September 5-8, 2021

A. Cossu, D. Bacciu, A. Carta, C. Gallicchio, V. Lomonaco, 2021 "Continual Learning with Echo State Networks", European Symposium on Artificial Neural Networks (ESANN 2021), October 6-8, 2021

A. Cossu, A. Carta, V. Lomonaco, D. Bacciu, D., 2021. "Continual Learning for Recurrent Neural Networks: An Empirical Evaluation", Neural Networks.

J. Valtl, V. Issakov. "Frequency Modulated Continuous Wave Radar-Based Navigation Algorithm using Artificial Neural Network for Autonomous Driving" In: 2021 24th IEEE International Conference on Intelligent Transportation Systems - ITSC2021

SUBMITTED DELIVERABLES

D1.2 Report on TEACHING related technologies SoA and derived CPSoS requirements (HUA, R, PU)
D2.2 Refined requirement specifications and preliminary release of the computing and communication platform (CNR, R, PU)
D3.2 Interim Report on Engineering Methods and Architecture Patterns of Dependable CPSoS (TUG, R, PU)
D4.2 Report on integrated mockup of the AIaaS system (UNIPI, R, PU)
D5.2 Preliminary use case deployment, implementation and integration report with related dataset release (AVL, R, PU)
D6.3 Mid-term update of stakeholders' engagement plan, dissemination and exploitation mid-term reports (ITML, R, CO)
D6.4 Market analysis, business plan and long-term sustainability report (ITML, R, PU)
D7.2 Midterm management report (UNIPI, R, CO)

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Key Facts

Project Coordinator: Dr. Davide Bacciu
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Start: 1-1-2020
Duration: 36 months
Participating organisations: 10
Number of countries: 5

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Fundings

This project has received funding from the European Union's Horizon 2020 Research and Innovation program under grant agreement No 871385.

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