# TEACHING NEWSLETTER

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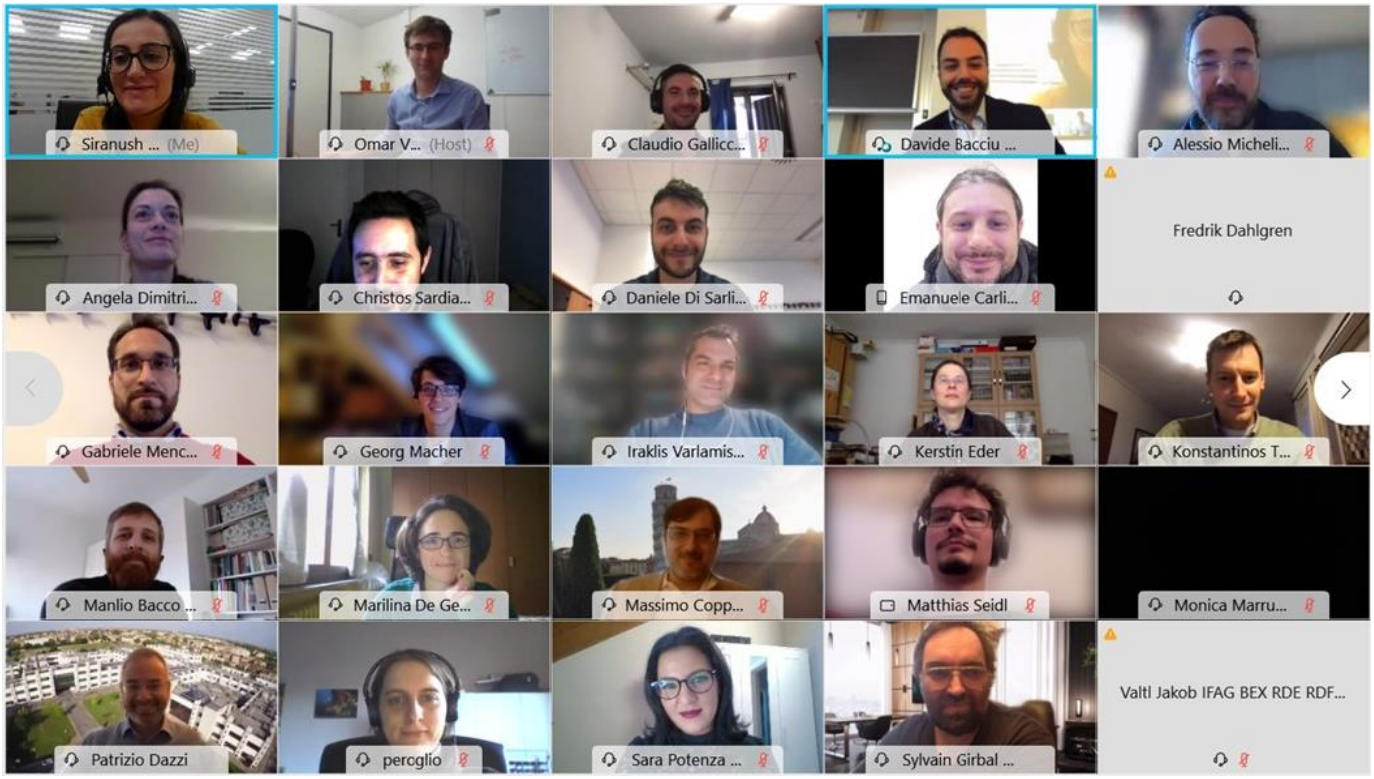
*TEACHING is an EU-funded project that designs a computing platform and the associated software toolkit supporting the development and deployment of autonomous, adaptive, and dependable CPSoS applications, allowing them to exploit sustainable human feedback to drive, optimize and personalize the provisioning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

This issue provides a grasp of the main project developments in the period of October 2020 - March 2021. It also provides facts on the results achieved, as well as links to the latest project publications, webinars, events, etc. Enjoy reading it!

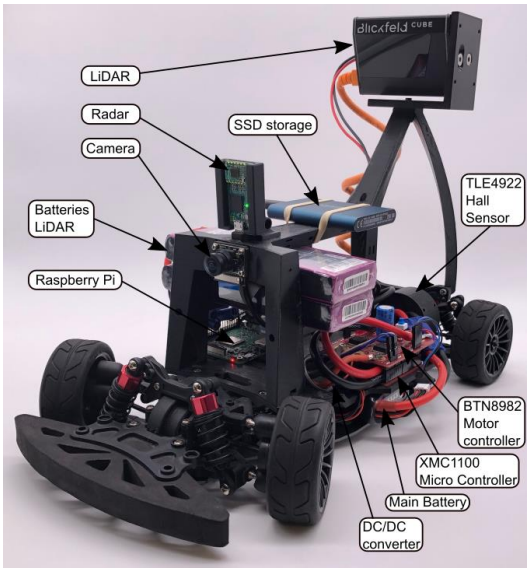
2020 has been a challenging year universally, obliging people to adapt to new experiences. As all EU projects, TEACHING had to quickly adopt new ways of working to avoid serious issues and delays. Despite the challenges, 2021 has started with a successful milestone. We are proud to announce that the TEACHING partners performed a great success during the 1st technical review meeting and according to the reviewers' report, all the planned milestones, results and deliverables have been reached successfully.

## A Big Milestone Achieved



# WHAT HAS BEEN DONE?

After the 1st technical review meeting, HUA, with the assistance of UNIPI, has started outlining an integration plan, which defines how the different souls of the TEACHING system will come together as a unified toolkit, integrating distributed learning functionalities over a pervasive computing system, while enforcing cybersecurity and safety properties. This integration plan will lead to the TEACHING platform MVP, which is expected to showcase the deployment of application components on top of a computing and communication execution platform which itself is hosted on embedded systems. The whole environment will support DL functionalities to the autonomous operation of the applications, whereas its architecture will be following a set of procedures to ensure the safety of the intended operations. In addition, relevant third-party technologies and libraries to be integrated were identified within the TEACHING system to support its functionalities, regarding the neural network implementation, privacy-preservation and support to data stream processing. In the scope of WP2, UNIPI has been benchmarking a prototype of a computing framework for high-speed streaming on edge resources. In particular, UNIPI is experimenting with embedded systems equipped with ARM multicores and NVIDIA GPUs (Jetson Nano) and FPGAs (Terasic Han Pilot Platform). The research unit is working on the design of 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. Currently, the unit is designing a methodology to identify key functional units of the neural network models developed in TEACHING and their mapping into computational components of the stream processing framework, with the purpose of accelerating their calculation leveraging the underlying multicore and co-processor computing system. Furthermore, as part of T2.1, TRT continued the discussion on the selection of the hardware platform, with regard to the requirements of the avionics use-case. In this regard, I&M is working together with other partners in the definition of the cloud-edge communication infrastructure. Over the last months, Infineon investigated and started building 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 which is also an Infineon radar sensor monitoring the car's environment. The software for operation is currently in the initial testing phase and capable of gathering data streams to generate datasets on which future AI algorithms will be trained. Regarding the WP3 activities, UNIPI has been collaborating on the design of dependability engineering schemes supporting the integration of AI-based components with safety-critical architecture. Currently, the partners are studying and designing techniques allowing to define risk assessment metrics specialized for the family of neural network models developed in TEACHING, which are recurrent randomized neural networks. Furthermore, UNIPI is working together with Marelli to



define of a regulatory scheme and accepted standard for the inclusion of these neural components into highly dependable and safety certified CPS. In continuation of the efforts to deal with the performance degradation issue in continual training settings, HUA conducted a number of experiments to test rehearsal training techniques that show the most promising solutions in the literature. It has been realized that there is a significant overhead caused by the retraining process when integrating new knowledge to existing in a stream processing scenario. Towards that end, various mechanisms to mitigate the issue have been tested and the results will be presented soon. Marelli has contributed to WP3 activities starting with a review of proposed architectures for dependability, with an accurate inspection from the functional safety perspective. To consider dependable an AI-based system, it is necessary to validate the actions (i.e., the output data) of the AI itself, by developing a "new" safety case. Therefore, the partners from Marelli are working on creating a safety case based on SOTIF and ISO 26262 merged standards. The merging of SOTIF and ISO26262 workflow is ongoing and will be part of the work within WP3.


The WP4 activities have also been progressed during the last months. The WP4 leader, in cooperation with other partners, conducted a survey on the state-of-the-art on Human State Monitoring. The survey has a strong focus on the applicability of Machine Learning algorithms and techniques to detect the physiological state of a subject from the biological signals that can be collected from non-invasive sensors. Moreover, jointly with other WP4 partners, UNIPI started the design of an architecture for the AI-as-a-Service system for federated learning. The structure of the framework that is being proposed will allow to easily design distributed applications that take advantage of federated learning. UNIPI is also actively working on the topics of Continual Learning, Privacy Preserving and Dependable and Safe algorithms for Recurrent and Reservoir Computing Neural Networks. The backbone objective of these research directions is to devise flexible approaches to address learning algorithms that can adapt faster and with strong theoretical guarantees on the learned behaviors. HUA continued its experiments with the open-source simulator for autonomous driving (CARLA) for identifying mechanisms that can profile the passengers' behavior and accordingly adapt the driving style. A speed-limit MPC controller demonstrated good results in scenarios where the human stress was based solely on simple definitions such as acceleration thresholds. Further experimentation is now conducted in more complex scenarios, with the intention to extend the controller-based design with a DL-based design that will allow for higher granularity solutions. Marelli has analyzed the architectural solution proposed within the TEACHING project, with a specified focus on the dependability of AI and DNN based systems. Marelli aims to define a methodology to establish a link between dependability evaluation and functional safety integrity level definition. 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, is ongoing.


Moving away from the earlier rough definition of TEACHING use cases, several WP5 mini workshops have focused on the appropriate mapping of anticipated technical development to the two industrial domains (avionics and automotive). The resulting commonalities between the use cases are exploited for a single technical path. The anticipated outcomes are then to be tailored to each domain. The workshops have considered the domain-specific customization to satisfy the project requirements with the minimal technological divergence between the two use cases. Aside from the application-specific activities, in close collaboration with WP3, WP5 has resulted in a tool for early-stage automotive development. The tool is a simplified and inexpensive replacement of more powerful

prototyping systems, which are generally used for the detection of development flaws. The tool also doubles up as an intelligent watchdog for testing newly developed automotive functions and as Ethernet-CAN Gateway, which enables remote access to the development platforms in their real environments. The related work has been successfully presented in the 7th International Workshop on Automotive System/Software Architectures (WASA) at the 18th IEEE International Conference on Software Architecture (ICSA 2021).

## TEACHING DISSEMINATION and COMMUNICATION

During the last six-month period, the partners have managed to organize several webinars creating good opportunities for networking with peers. During these sessions, the consortium members from UNIPI, Marelli and AVL were able to deliver detailed lectures and spread knowledge about *Computing Neural Networks*, *Operational Safety* and *Automotive Driving Simulator* topics. Additionally, fundamental AI concepts connected with the development conducted within the aims of the TEACHING project have also been disseminated through a series of webinars and tutorials, among which the outstanding AAAI conference, which took place virtually, in February 2021. Currently, UNIPI, jointly with TUG and Marelli, leads the organization of the special session on "Dependable AI for Autonomous Vehicles" during the 19th IEEE International Conference on Dependable, Autonomic & Secure Computing - DASC 2021. In parallel, UNIPI leads the organization of an accepted workshop on "Deep Learning in Unconventional Neuromorphic Hardware" (Workshop of the International Joint Conference on Artificial Neural Networks - IJCNN 2021). Interestingly, a PhD thesis on the topic of federated learning for personalization of profiles in autonomous driving while considering human comfort has been assigned by HUA. Meanwhile, in cooperation with Marelli and AVL, TUG is envisioning to further disseminate and promote dependability engineering practices to regulatory and standardization working groups in the automotive domain.

TEACHING values the importance of networking, exchanging ideas and knowledge with other similar EU projects. Most importantly, at this project's lifecycle, the consortium has managed to generate discussions with H2020 TAILOR, DRIVES and OpenInnoTrain projects on the same topic, aiming at the co-organization of special sessions as well as boosting joint dissemination activities.

**Liaison activities are in progress**

Special Podcast Sessions

**Coming Soon!**

Although the outreach activities continue with weekly posts on social media platforms (LinkedIn and Twitter), the TEACHING team plans to increase knowledge and visibility of the project by raising awareness of the benefits of the TEACHING platform and the associated toolkits via special podcast sessions.

## 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 is shown below:

PCI 2020
24th Pan-Hellenic Conference on Informatic

K. Giorgas, I. Varlamis, "Online Federated Learning with Imbalanced Class Distribution", Panhellenic Conference on Informatics (PCI2020), November 2020

J. Valtl, J. Mendez, M. Pegalajar and V. Issakov, "Autonomous Platform based on Small-Scale Car for Versatile Data Collection and Algorithm Verification", 25th International Conference on Pattern Recognition (ICPR2021), January 2021

M. Dzambic, C. Kreuzberger, O. Veledar and G. Macher (2021) "A Rapid Prototyping System, Intelligent Watchdog and Gateway Tool for Automotive Applications', (7th WASA) at the 18th IEEE International Conference on Software Architecture (ICSA 2021) March 2021

Andrea Valenti Michele Barsotti, Davide Bacciu; Ascari, Luca, A Deep Classifier for Upper-Limbs Motor Anticipation Tasks in an Online BCI Setting, Bioengineering, 8(2), 21, 2021

Bacciu, Davide; Bertoncini, Gioele; Morelli, Davide, Topographic mapping for quality inspection and intelligent filtering of smart-bracelet data, Neural Computing Applications, 2021

M. V. Bordin, D. Griebler, G. Mencagli, C. F. R. Geyer and L. G. L. Fernandes, "DSPBench: A Suite of Benchmark Applications for Distributed Data Stream Processing Systems", IEEE Access, vol. 8, pp. 222900-222917 2020

## SUBMITTED DELIVERABLES

D1.1 Report on TEACHING related technologies SoA and derived CPSoS requirements (HUA, R, PU)
D2.1 State-of-the-art analysis and preliminary requirement specifications for the computing and communication platform (CNR, R, PU)
D3.1 Initial Report on Engineering Methods and Architecture Patterns of Dependable CPSoS (TUG, R, PU)
D4.1 Initial report on the AIaaS system (UNIPI, R, PU)
D5.1 Initial use case specifications (AVL, R, CO)
D6.1 Initial plans for stakeholders' engagement, dissemination and exploitation of results (ITML, R, PU)
D6.2 Data Management Plan (UNIPI, R, CO)
D7.1 Project Management Plan (UNIPI, R, CO)
D7.5 Ethics compliance and monitoring (UNIPI, R, CO)

### 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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EUROPEAN UNION