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Publishable Executive Summary

PANDA develops a uniform organization of models of electrified vehicles and a common cloud of models for virtual testing (pure simulation) and real testing (power hardware-in-the-loop - P-HiL - testing) of their components. In WP4, a BEV, a FCV and a HEV have been virtually tested using this method and the cloud of models. In WP5, these models have been used in real-time for the P-HiL testing of the battery, the e-drive and the e-subsystems of the studied P-HEV. But these tests were achieved in stand-alone P-HiL testing, uploading the models in a local real-time ECU.

In this work, cloud-based P-HiL testing of battery has been achieved for a BEV and a P-HEV, i.e. the reference vehicles of PANDA. The real-time simulation is, split into a real-time local simulator and a cloud simulation that exchange data in real time. The objective of this work is to demonstrate the flexibility of the PANDA method from pure simulation to cloud-based P-HiL testing.

The same battery (provided by Blueways) has been tested using the same local real-time ECU (Typhoon HIL) and the same cloud environment using Simcenter AMESIM © (SISW). An Ethernet connection has been used between the local real-time simulator and the Cloud.

This battery has been tested for the BEV at Brussels with the experimental equipment of VUB. The same battery has been tested for the P-HEV at Lille with the experimental equipment of ULille. Despite the differences in power interface and models of the two vehicles, successful cloud-based P-HiL testing have been achieved using a common procedure. This point demonstrated the ability of the PANDA method to operate with different set-up, and also the interest to share a cloud of models.

In Brussels, the real-time model in the local simulators only contains the simulation of the auxiliaries and the power adaption. The other parts of the model have been simulated in the cloud. For model of level 0 (static models of the e-drive), the test can be easily perform. For models of level 1 (dynamic model of the e-drive), the communication delay is too close to the e-drive dynamics to enable a stable real-time simulation.

To solve this issue, the two e-drives of the P-HEV have been simulated in the local ECU for the P-HEV at the ULille experimental platform. The mechanical transmission, vehicle control and energy management are computed in real-time on the cloud. Despite the complexity of the model of this hybrid vehicle and its control, the cloud-based HiL testing has been achieved successfully.

It can be highlighted that both testing have been developed in parallel in a fast and easy way because of the PANDA methodology. Therefore, the EMR organization of the models enables a clear and fair decomposition of the models for different splitting solutions thanks to the fixed I/Os between the different parts of the models and the controls.

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Table 1: Project Partners

#	Type	Partner	Partner Full Name
1	UNIV	ULille	Université de Lille
2	IND	SISW	Siemens Industry Software SRL
3	UNIV	VUB	Vrije Universiteit Brussels
4	IND	VEEM	VALEO Equipement Electriques Moteur SAS
5	UNIV	UTCN	Universitatea Tehnica Cluj Napoca
6	SME	TY	Tajfun HIL d.o.o. (Typhoon HIL)
7			
8	UNIV	UBFC	Université Bourgogne Franche-Comté
9	SME	UNR	Uniresearch BV
10	IND	RTR	Renault Technologie Roumanie
11	SME	Bluways	BlueWays International bva
12	IND	TUV	TUV SUD Battery Testing GmbH

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