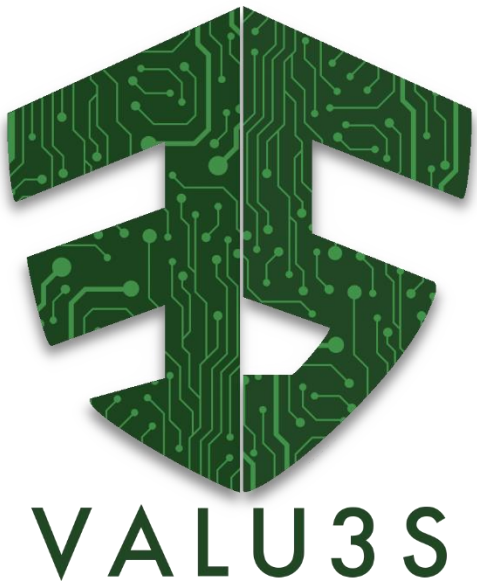


Verification and Validation of Automated Systems' Safety and Security

Final Dissemination and Training Activity Report

Document Type	Report
Document Number	D6.19
Primary Author(s)	David Pereira (ISEP)
Document Date	2023-04-27
Document Version	1.0 (Final)
Dissemination Level	Public (PU)
Reference DoA	2022-12-14
Project Coordinator	Behrooz Sangchoolie, behrooz.sangchoolie@ri.se, RISE Research Institutes of Sweden
Project Homepage	www.valu3s.eu
JU Grant Agreement	876852

This project has received funding from the ECSEL Joint Undertaking (JU) under grant agreement No 876852. The JU receives support from the European Union's Horizon 2020 research and innovation programme and Austria, Czech Republic, Germany, Ireland, Italy, Portugal, Spain, Sweden, Turkey.

Disclaimer

The views expressed in this document are the sole responsibility of the authors and do not necessarily reflect the views or position of the European Commission. The authors, the VALU3S Consortium, and the ECSEL JU are not responsible for the use which might be made of the information contained in here.

Project Overview

Manufacturers of automated systems and the manufacturers of the components used in these systems have been allocating an enormous amount of time and effort in the past years developing and conducting research on automated systems. The effort spent has resulted in the availability of prototypes demonstrating new capabilities as well as the introduction of such systems to the market within different domains. Manufacturers of these systems need to make sure that the systems function in the intended way and according to specifications which is not a trivial task as system complexity rises dramatically the more integrated and interconnected these systems become with the addition of automated functionality and features to them.

With rising complexity, unknown emerging properties of the system may come to the surface making it necessary to conduct thorough verification and validation (V&V) of these systems. Through the V&V of automated systems, the manufacturers of these systems are able to ensure safe, secure and reliable systems for society to use since failures in highly automated systems can be catastrophic.

The high complexity of automated systems incurs an overhead on the V&V process making it time-consuming and costly. VALU3S aims to design, implement and evaluate state-of-the-art V&V methods and tools in order to reduce the time and cost needed to verify and validate automated systems with respect to safety, cybersecurity and privacy (SCP) requirements. This will ensure that European manufacturers of automated systems remain competitive and that they remain world leaders. To this end, a multi-domain framework is designed and evaluated with the aim to create a clear structure around the components and elements needed to conduct V&V process through identification and classification of evaluation methods, tools, environments and concepts that are needed to verify and validate automated systems with respect to SCP requirements.

In VALU3S, 13 use cases with specific safety, security and privacy requirements will be studied in detail. Several state-of-the-art V&V methods will be investigated and further enhanced in addition to implementing new methods aiming for reducing the time and cost needed to conduct V&V of automated systems. The V&V methods investigated are then used to design improved process workflows for V&V of automated systems. Several tools will be implemented supporting the improved processes which are evaluated by qualification and quantification of safety, security and privacy as well as other evaluation criteria using demonstrators. VALU3S will also influence the development of safety, security and privacy standards through an active participation in related standardisation groups. VALU3S will provide guidelines to the testing community including engineers and researchers on how the V&V of automated systems could be improved considering the cost, time and effort of conducting the tests.

VALU3S brings together a consortium with partners from 10 different countries, with a mix of *industrial partners* (25 partners) from automotive, agriculture, railway, healthcare, aerospace and industrial automation and robotics domains as well as leading *research institutes* (6 partners) and *universities* (10 partners) to reach the project goal.

Consortium

RISE RESEARCH INSTITUTES OF SWEDEN AB	RISE	Sweden
STAM SRL	STAM	Italy
FONDAZIONE BRUNO KESSLER	FBK	Italy
KNOWLEDGE CENTRIC SOLUTIONS SL - THE REUSE COMPANY	TRC	Spain
UNIVERSITA DEGLI STUDI DELL'AQUILA	UNIVAQ	Italy
INSTITUTO SUPERIOR DE ENGENHARIA DO PORTO	ISEP	Portugal
UNIVERSITA DEGLI STUDI DI GENOVA	UNIGE	Italy
CAMEA, spol. s r.o.	CAMEA	Czech
IKERLAN S. COOP	IKER	Spain
R G B MEDICAL DEVICES SA	RGB	Spain
UNIVERSIDADE DE COIMBRA	COIMBRA	Portugal
VYSOKE UCENI TECHNICKE V BRNE - BRNO UNIVERSITY OF TECHNOLOGY	BUT	Czech
ROBOAUTO S.R.O.	ROBO	Czech
ESKISEHIR OSMANGAZI UNIVERSITESI	ESOGU	Turkey
KUNGLIGA TEKNISKA HOEGSKOLAN	KTH	Sweden
STATENS VAG- OCH TRANSPORTFORSKNINGSINSTITUT	VTI	Sweden
UNIVERSIDAD DE CASTILLA - LA MANCHA	UCLM	Spain
FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V.	FRAUNHOFER	Germany
SIEMENS AKTIENGESELLSCHAFT OESTERREICH	SIEMENS	Austria
RULEX INNOVATION LABS SRL	RULEX	Italy
NXP SEMICONDUCTORS GERMANY GMBH	NXP-DE	Germany
PUMACY TECHNOLOGIES AG	PUMACY	Germany
UNITED TECHNOLOGIES RESEARCH CENTRE IRELAND, LIMITED	UTRCI	Ireland
NATIONAL UNIVERSITY OF IRELAND MAYNOOTH	NUIM	Ireland
INOVASYON MUHENDISLIK TEKNOLOJI GELISTIRME DANISMANLIK SANAYI VE TICARET LIMITED SIRKETI	IMTGD	Turkey
ERGUNLER INSAAT PETROL URUNLERI OTOMOTIV TEKSTIL MADENCILIK SU URUNLER SANAYI VE TICARET LIMITED STI.	ERARGE	Turkey
OTOKAR OTOMOTIV VE SAVUNMA SANAYI AS - OTOKAR AS	OTOKAR	Turkey
TECHY BILISIM TEKNOLOJILERI DANISMANLIK SANAYI VE TICARET LIMITED SIRKETI - TECHY INFORMATION TECHNOLOGIESAND CONSULTANCY LIMITED COMPANY	TECHY	Turkey
ELECTROTECNICA ALAVESA SL	ALDAKIN	Spain
INTECS SOLUTIONS SPA	INTECS	Italy
LIEBERLIEBER SOFTWARE GMBH	LLSG	Austria
AIT AUSTRIAN INSTITUTE OF TECHNOLOGY GMBH	AIT	Austria
E.S.T.E. SRL	ESTE	Italy
NXP SEMICONDUCTORS FRANCE SAS	NXP-FR	France
BOMBARDIER TRANSPORTATION SWEDEN AB	BT	Sweden
QRTECH AKTIEBOLAG	QRTECH	Sweden
CAF SIGNALLING S.L	CAF	Spain
MONDRAGON GOI ESKOLA POLITEKNIKOA JOSE MARIA ARIZMENDIARRIETA S COOP	MGEP	Spain
INFOTIV AB	INFOTIV	Sweden
BERGE CONSULTING AB	BERGE	Sweden
CARDIOID TECHNOLOGIES LDA	CARDIOID	Portugal

Executive Summary

The objective of this deliverable is to report the work developed, in terms of activities focused on dissemination and training, along the duration of the project. For that reason, the document is structured in a way that closely reflects the final set of Key Performance Indicators (KPI) defined in the month 18 and already reported in D6.12 - *"Final Dissemination and Training Plan"* [1] (which in turn is an update of D6.3 – *"Initial Dissemination and Training Plan"* [5] where the initial set of dissemination and training KPIs was defined). What this deliverable shows is that all KPIs were successfully achieved within the timeframe of VALU3S (considering the 3-month extension, where indeed activities towards the realization of one of the KPIs, notably the organization of the VALU3S summer school, will take place).

Contributors

David Pereira ISEP Giann Nandi ISEP

Reviewers

Fredrik Warg	RISE	2023-04-06
Jose Luis de la Vara	UCLM	2023-04-07
Ahmet Yazıcı	ESOGU	2023-04-08
Behrooz Sangchoolie	RISE	2023-04-20, 2023-04-27

Revision History

Version	Date	Author (Affiliation)	Comment
0.1	2023-04-04	David Pereira (ISEP), Giann Nandi (ISEP)	Initial Version of the deliverable submitted for internal evaluation.
0.2	2023-04-07	David Pereira (ISEP)	Integration of comments from the first internal review process.
0.3	2023-04-18	David Pereira (ISEP)	Update of the document with the inputs related to the dissemination and training indicators.
0.4	2023-04-24	David Pereira (ISEP)	Update of the document with the inputs from the 2nd internal review.
0.9	2023-04-27	Behrooz Sangchoolie (RISE)	Reviewing the final draft while making minor formatting changes.
1.0	2023-04-27	Behrooz Sangchoolie (RISE)	Final report to be submitted.

Table of Contents

List of Figures

List of Tables

Acronyms

D	Deliverable
DECT	Dissemination, Exploitation and Communication Team
DoA	Description of the Action
EC	European Commission
EU	European Union
GA	Grant Agreement
HRB	Horizon Results Booster
JU	Joint Undertaking
KPI	Key Performance Indicator
PC	Project Coordinator
PCA	Project Consortium Agreement
T	Task
VALU3S	Verification & Validation of Automated Systems' Safety and Security
V&V	Verification & Validation
WP	Work package

Chapter 1 Dissemination and Training KPIs

In this chapter, we present the Key Performance Indicators (KPIs) related to dissemination and training activities, including how they have evolved from a first set of KPIs established after the selection of the project for funding, up to the time of the delivery of the final plan for dissemination and training, which establishes the KPIs that are subject to evaluation by the end of the project.

1.1 Initial set of dissemination and training KPIs

In this section, we recall the original dissemination and training KPIs established after acceptance of project for funding. An original set of KPIs was introduced during the DoA preparation (as it was missing in the project's approved proposal), but that set included some KPIs that focused on communication activities. Also, explicit training KPIs were missing. The original set of KPIs is presented in Table 1.1., with all identifiers prefixed with the "OLD" word to distinguish clearly from the final set of KPIs to be presented and discussed further ahead in this document.

Table 1.1: List of dissemination KPIs defined during DoA preparation.

KPI	Description	Value
OLD-Diss-KPI-1	Average number of journal papers, newspaper/magazine articles per year	≥ 5
OLD-Diss-KPI-2	Average number of conference and workshop papers per year	≥ 20
OLD-Diss-KPI-3	Total number of VALU3S workshops organized per year	≥ 2
OLD-Diss-KPI-4	Participation in fairs and exhibitions per year	≥ 3
OLD-Diss-KPI-5	Number of speeches in public events per year	≥ 3
OLD-Diss-KPI-6	Number of accesses to the VALU3S website per year	≥ 2000
OLD-Diss-KPI-7	Number of new followers in social media channels per year	≥ 500
OLD-Diss-KPI-8	Number of VALU3S results made available as Open Source projects (e.g. tools, tutorials, training materials)	≥ 5
OLD-Diss-KPI-9	Number of industrial publications	≥ 5
OLDDiss-KPI-10	Average Number of new recipients of press-releases per year	≥ 100

In order to be more precise on what the KPIs would measure in terms of dissemination and training activities, the KPIs focusing on communication have been dropped (and adopted in the communication KPIs addressed by Task 6.4) and a new estimation of the objectives for each of the remaining KPIs was updated taking into account the results of a specific survey that was distributed to the consortium with the purpose of obtaining the partners expectations about the values that should be associated with each of the KPIs. In that survey, partners were also asked to suggest new KPIs, which resulted on adding a new KPI that targets the organization of summer schools, and therefore focused on training. The final

list of KPIs before the major revision that took place when finalizing the preparation of the final dissemination and training plan, reported in D6.12 [1] , is presented in Table 1.2.

Table 1.2: List of dissemination and training KPIs before major revision.

KPI	Description	Original Value	Updated Value
OLD-Diss-KPI-1	Average number of journal papers, newspaper/magazine articles per year	≥ 5	≥ 10
OLD-Diss-KPI-2	Average number of conference and workshop papers per year	≥ 20	≥ 25
OLD-Diss-KPI-3	Total number of VALU3S workshops organized per year	≥2	≥2
OLD-Diss-KPI-4	Participation in fairs and exhibitions per year	≥ 3	≥ 10
OLD-Diss-KPI-5	Number of speeches in public events per year	≥ 3	≥ 10
OLD-Diss-KPI-6	Number of VALU3S results made available as Open-Source projects (e.g. tools, tutorials, training materials)	≥ 5	≥ 15
OLD-Diss-KPI-7	Number of industrial publications	≥ 5	≥ 10
OLD-Diss-KPI-8	Number of summer schools organized	N/A	≥ 1

As can be seen in Table 1.2, an interval of values was defined for each KPI, instead of a single value as target (except for the new OLD-Diss-KPI-8). This interval's lower bound corresponds to the values initially proposed during the DoA preparation, and the upper bound the values inferred from the inputs of the partners based on their answers to the survey.

The final set of dissemination and training Key Performance Indicators (KPIs), established at month 18 of the project as a result from internal evaluation of the initially proposed set of KPIs (presented in D6.3 [5]). A more detailed explanation of planning and establishing the final set of KPIs for VALU3S is provided in D6.12 [1].

1.2 Final set of dissemination and training KPIs

In this section, we revisit the assessment that was performed by the consortium regarding the original set of dissemination and training KPIs established in the project, as discussed in the previous section. This assessment resulted in a revision of those KPIs and gave rise to the final set of dissemination and training KPIs that are presented and described in Section 1.2.1 and Section 1.2.2, which are the ones being reported in terms of the achievements of the project regarding these two activities of the project. The efforts that were conducted to reach the final set of dissemination and training KPIs has already been reported in D6.12 [4], hence we omit that explanation on this deliverable, and we rather focus on the final results achieved during the total duration of the project.

1.2.1 Dissemination KPIs

Regarding dissemination, the set of final KPIs is presented in Table 1.3. These KPIs consist essentially of: (1) a more flexible way of measuring publication efforts during the project (both for academic and

industrial publications), (2) the involvement of VALU3S in the organization or sponsoring workshops open to the community, and (3) a more realistic number of open-source projects resulting from work performed by the partners in the project.

Table 1.3. Final set of dissemination KPIs.

KPI	Description	Value
Diss-KPI-1	Total number of publications	≥ 90
Diss-KPI-2	Total number of workshops organized or sponsored by VALU3S	≥ 3
Diss-KPI-3	Total Number of VALU3S results made available as open-source projects	≥ 15

We now provide short descriptions of each of the dissemination KPIs to give more context that supports the results collected along the second year of the project, and that are evaluated and reported in the current deliverable.

Diss-KPI-1: Total number of publications

This dissemination KPI accounts for the total number of publications accepted throughout the complete duration of the project. The target value to achieve is that of at least 90 publications of any of the following main types of publications: books, book chapters, poster, workshop papers, conference paper, journal papers, academic thesis. However, dissemination activities such as invited talks or key talks, given by partners and supported by VALU3S, are also considered.

Diss-KPI-2: Total number of workshops organized or sponsored by VALU3S

The indicator Diss-KPI-2 has now a different interpretation of the meaning of what a workshop is in the scope of VALU3S. In the initial plan, workshops had no specific definition associated with them, and thus the implicit interpretation was that they referred to events organized both internally and externally to the project and had VALU3S partners involved in the organization. Hence, to avoid ambiguous interpretation, and thus measuring activities related to workshop involvement, we consider workshops as events targeting an audience external to the project, not being what could be considered as training.

We also consider in this KPI the sponsoring of workshops by the project, where members of the partners do not need to be actively leading activities of the organization and maybe just members of the workshop's committees.

Diss-KPI-3: Total Number of VALU3S results made available as open-source projects

This indicator is a new version of the old KPI focusing on the contributions of the project to the open-source community (whose list is reported in Section 2.5 of this document). It sets up the number of open-source projects that have origin in the R&D work developed in the project, excluding tutorials and videos, which were considered in the first version of the KPI.

Also, the number of open-source projects that VALU3S aims to achieve is now updated to 15, instead of the old value of 5, which was an unrealistically low objective considering the size of the consortium and the number of activities being planned for open-source contributions of the project.

1.2.2 Training KPIs

In this section we revisit the set of dedicated KPIs established to evaluate the project's performance in the area of training. The list of KPIs dedicated to training evaluation is presented in Table 1.4.

Table 1.4. Final set of training KPIs.

KPI	Description	Value
Train-KPI-1	Total number of training materials developed by the project	≥ 25
Train-KPI-2	Total number of internal training sessions	≥ 6
Train-KPI-3	Total number of training sessions open to external audience	≥ 1
Train-KPI-4	Organization of summer or winter schools	≥ 1

Train-KPI-1: Total number of training materials developed by the project.

This KPI intends to measure the number of contents made available (e.g., method or tool videos, slides, manuals, etc.) both internally and externally to the project. This should include not only the materials that naturally arise for the internal training sessions (that VALU3S management and dissemination/communication bodies have decided to make available whenever possible); it also includes videos that partners have prepared on their methods & tools (and possibly the improvements/combinations that they produce during the project). Also, it includes other materials such as user manuals, tutorial documents, and similar documents that may be developed to document the associated technical developments (however, associated scientific/industrial publications are not accounted for by this KPI as these are covered already by Diss-KPI-1).

Train-KPI-2: Total Number of Internal Training Sessions.

The objective of this KPI is to measure the project's performance in what concerns the organization of internal training sessions. As can be seen further ahead in this deliverable, several training sessions have been organized, which during the first year of the project have been focused on methods & tools that partners have brought to the project, and during the second-year and beyond focused on standardization. The effort on organizing training sessions dedicated to other subjects than baseline methods & tools and standardization are being considered (e.g., training dedicated to use cases, training focused on the process of developing patents, etc).

Train-KPI-3: Total Number of Training Sessions Open to External Audience.

This is a new KPI that is proposed to be achieved during the project. The objective is the organization of at least one training session for a group of individuals/organizations that are not part of the VALU3S consortium. The target audience is expected to include members of the industry interested in the topics about V&V of SCP properties in automated systems.

Train-KPI-4: Organization of Summer or Winter Schools.

This KPI remains in its original form, but its identifier is renamed to fit the category of training KPIs. The objective is to organize at least one summer/winter school during the project. Such organization and realization are expected to occur by the end of the project when results are mature enough to serve as content for the future sessions that such school will include.

Chapter 2 Dissemination Activities

In this section we report the activities performed throughout the project that focused on dissemination, following along the final KPIs presented in the previous chapter.

2.1 Publications Obtained During the Project

Publications are one of the most relevant indicators that can be used to measure the outreach of VALU3S results to academia and industrial stakeholders with interest in the areas addressed by the project. The 90 publications obtained until the time of writing this deliverable, from year one to year 3 of the project, are presented, respectively, in Table 2.1., Table 2.2, and Table 2.3. In each of these tables, the rightmost column identified as "Ind. Pub?" refers to the fact of the said publications being considered as industrial or not (criteria to consider a publication industrial are: i) at least one of the authors is from an industrial partners; or ii) the venue of the publication is clearly focused on industrial reporting of results; these concerns are clearly described in D6.12 [4]).

Table 2.1. Year 1 publications.

Nr.	Full Reference of the Publication	Ind. Pub?
1	Barbosa, R., Basagiannis, S., Giantamidis, G., Becker, H., Ferrari, E., Jahic, J., Kanak, A., Labayen Esnaola, M., Orani, V., Pereira, D., Pomante, L., Schlick, R., Smrcka, A., A. Yazici, P. Folkesson, B. Sangchoolie. "***The VALU3S ECSEL Project: Verification and Validation of Automated Systems Safety and Security***", 23rd Euromicro Conference on Digital System Design (DSD), 26-28 Aug. 2020, Kranj, Slovenia	yes
2	Homoliak, I., Breitenbacher, D., Hujnak, O., Hartel, P., Binder, A., Szalachowski, P. ***"SmartOTPs: An Air-Gapped 2-Factor Authentication for Smart-Contract Wallets"***, 2nd ACM Conference on Advances in Financial Technologies (AFT '20), online (organized from New York, USA), 2020	no
3	de la Vara, J.L., Parra, E., Ruiz, A., Gallina, B. ***"The AMASS Tool Platform: An Innovative Solution for Assurance and Certification of Cyber-Physical Systems"***, 26th International Working Conference on Requirements Engineering: Foundation for Software Quality (REFSQ 2020), CEUR Workshop Proceedings, vol. 2584, Pisa, Italy, 2020	no
4	de la Vara, J.L., Marin, B., Ayora, C., Giachetti, G. ***"An Empirical Evaluation of the Use of Models to Improve the Understanding of Safety Compliance Needs, Information and Software Technology"***, vol. 126, 2020	no

Nr.	Full Reference of the Publication	Ind. Pub?
5	López, B., Álvarez-Rodríguez, J.M., Parra, E., de la Vara, J.L. ***"Ontology Configuration Management for Knowledge-Centric Systems Engineering in Industry"***, 50th IEEE/IFIP International Conference on Dependable Systems and Networks (DSN 2020), Valencia, Spain, 2020	no
6	de la Vara, J.L., Ruiz, A., Blondelle, G. ***"Assurance and Certification of Cyber-Physical Systems: The AMASS Open Source Ecosystem"***, Journal of Systems and Software. Vol. 171, 2020	no
7	Roda-Sanchez, L., Olivares, T., Garrido-Hidalgo, C., de la Vara, J.L., Fernández-Caballero, A. ***"Human-Robot Interaction in Industry 4.0 based on an Internet of Thing Real-Time Gesture Control System"***, Integrated Computer-Aided Engineering, vol. 28, no. 2, pp. 159-175, 20217	no
8	M. Belmonte, L., S. García, A., Morales, R., de la Vara, J.L., Fernández-Caballero, A. ***"Feeling of Safety and Comfort Towards a Socially"***, Sensors 2021, 21(3), 908	no
9	Nandi, G., Pereira, D., Proença, J., Tovar, E. ***"Work-In-Progress: a DSL for the safe deployment of Runtime Monitors in Cyber-Physical Systems"***, 41st IEEE Real-Time Systems Symposium, Huston, Texas, USA, 2020	no
10	Cledou, G., Proença, J., Sputh, B., Verhulst, E. ***"Hubs for VirtuosoNext: Online Verification of Real-Time Coordinators"***, Science of Computer Programming, Special Issue on Selected Tool Papers of the 21st International Conference on Coordination Models and Languages, COORDINATION 2019, vol. 203, 2020	no
11	Goncharov, S., Neves, R., Proença, J. ***"Implementing Hybrid Semantics: From Functional to Imperative"***, Theoretical Aspects of Computing – ICTAC 2020, LNCS vol. 12545, 2020	no
12	B. Sangchoolie, K. Pattabiraman and J. Karlsson ***"An Empirical Study of the Impact of Single and Multiple Bit-Flip Errors in Programs"***, IEEE Transactions on Dependable and Secure Computing	no
13	Smarra, F. and D'Innocenzo, A. ***"Learning Markov Jump Affine Systems via Regression Trees for MPC"***, IFAC World Congress, 2020	no
14	Masti, D., Smarra, F., D'Innocenzo, A., and Bemporad, A. ***"Learning affine predictors for MPC of nonlinear systems via artificial neural networks"***, IFAC World Congress, 2020	no
15	Kuhn, T., Antonino, P.O., Bachorek, A. ***"A Simulator Coupling Architecture for the Creation of Digital Twins"***, ECSA Companion 2020: 326-339, 2020	no
16	Jahic, J., Bauer, T., Kuhn, T., when, N., Antonino, P.O. ***"FERA: A Framework for Critical Assessment of Execution Monitoring Based Approaches for Finding Concurrency Bugs"***, SAI (1) 2020: 54-74	no

Nr.	Full Reference of the Publication	Ind. Pub?
17	Treichel, T., Antonino, P.O., Santos, F.S., Rosa, L.S. ***"Simulation-as-a-Service: a simulation platform for cyber-physical systems"***, ICSA 2021, WASA Workshop, 2021	no
18	Borg, M., Abdessalem, R.B., Nejati, S., Jegeden, F-X. Shin, D. ***"Digital Twins Are Not Monolythic -- Cross-Replicating ADAS Testing in Two Industry-Grade Automotive Simulators"***, Proc. of the IEEE International Conference on Software Testing, Verification and Validation (ICST) 2021, 12-16 April 2021	no
19	Borg, M., Bronson, J., Christensson, L., Olsson, F., Lennartsson, O., Sonnsjö, E., Ebabi, H., Karsberg, M. ***"Exploring the Assessment List for Trustworthy AI in the Context of Advanced Driver-Assistance Systems"***, Proc. of the 2nd Workshop on Ethics in Software Engineering Research and Practice	no
20	Borg, M., Jabangwe, R., Åberg, S., Ekblom, A., Hedlund, L., Lidfeldt, A. ***"Test Automation with Grad-CAM Heatm–ps - A Future Standard Pipe Segment in MLOps for Vision AI"***, Proc. of the 1st International Workshop on DevOps Testing for Cyber-Physical Systems	no
21	Mover, S., Cimatti, A., Griggio, A., Irfan, A., Tonetta, S. ***"Implicit Semi-Algebraic Abstraction for Polynomial Dynamical Systems"***, Proc. of the 33rd International Conference on Computer-Aided Verification (CAV-21)	no
22	Markwirth, T., Jancke, R., Sohrmann, C.: ***"Dynamic Fault Injection Into Digital Twins of Safety-Critical Systems"***, Design, Automation and Test in Europe Conference, DATE 2021, Virtual Conference and Exhibition, 1-5 February 2021.	no

Table 2.2. Year 2 publications.

Nr.	Full Reference of the Publication	Ind. Pub?
23	Farrell, M., Luckcuck, M., Sheridan, O., & Monahan, R. ***"FRETting about Requirements: Formalized Requirements for an Aircraft Engine Controller"***, in International Working Conference on Requirements Engineering: Foundation for Software Quality (pp. 96-111), 2022. Springer.	no
24	Farrell, M., Luckcuck, M., Sheridan, O., & Monahan, R. ***"Towards Refactoring FRETish Requirements,"*** in NASA Formal Methods: 14th International Symposium (272-279), 2022, Springer	no
25	Luckcuck, M., Farrell, M., Sheridan, O., & Monahan, R. ***"A Methodology for Developing a Verifiable Aircraft Engine Controller from Formal Requirements,"*** in IEEE Aerospace Conference, 2022	no

Nr.	Full Reference of the Publication	Ind. Pub?
26	Kanak, A, et al., ***"Verification and validation of an automated robot inspection cell for automotive body-in-white: a use case for the VALU3S ECSEL project"***, vol. 1, num. 115, Open Research Europe, 2021	yes
27	Maleki, M. and Sangchoolie, B., ***"SUFI: A Simulation-based Fault Injection Tool for Safety Evaluation of Advanced Driver Assistance Systems Modelled in SUMO,"*** 2021 17th European Dependable Computing Conference (EDCC), 2021, pp. 45-52	no
28	Maleki, M. and Sangchoolie, B., ***"Simulation-based Fault Injection in Advanced Driver Assistance Systems Modelled in SUMO"***, 2021 51st Annual IEEE/IFIP International Conference on Dependable Systems and Networks - Supplemental Volume (DSN-S), 2021	no
29	de la Vara, J., et al., ***"A Proposal for the Classification of Methods for Verification and Validation of Safety, Cybersecurity, and Privacy of Automated Systems"***. In Quality of Information and Communications Technology. QUATIC 2021. Communications in Computer and Information Science, vol 1439. Springer, Cham	yes
30	Bauer, T., et al., ***"Cross-domain Modelling of Verification and Validation Workflows in the Large Scale European Research Project VALU3S,"*** Proceedings of the International Conference on Embedded Computer Systems: Architectures, Modeling and Simulation (SAMOS XXI), 2021	yes
31	Hijazi, H., et al., ***"iReview: an Intelligent Code Review Evaluation Tool using Biofeedback,"*** 2021 IEEE 32nd International Symposium on Software Reliability Engineering (ISSRE), 2021, pp. 476-485	no
32	Cerveira, F., Barbosa, R., and Madeira, H., ***"Mitigating Virtualization Failures Through Migration to a Co-Located Hypervisor,"*** in IEEE Access, vol. 9, pp. 105255-105269, 2021	no
33	Cerveira, F., Domingos, J., Barbosa, R., and Madeira, H., ***"Measuring lead times for failure prediction,"*** 2021 IEEE 26th Pacific Rim International Symposium on Dependable Computing (PRDC), pp. 1-5, 2021	no
34	Paiva, D., et al., ***"Fault injection platform for affordable verification and validation of CubeSats software,"*** 2021 10th Latin-American Symposium on Dependable Computing (LADC), 2021	no
35	Borg, M., ***"Agility in Software 2.0 – Notebook Interfaces and MLOps with Buttresses and Rebars".*** In: Przybyłek, A., Jarzębowicz, A., Luković, I., Ng, Y.Y. (eds) Lean and Agile Software Development. LASD 2022. Lecture Notes in Business Information Processing, vol 438. Springer, Cham	no
36	Yayan, U. and Erdoğmuş, A., ***"Endüstriyel Robot Hareket Planlama Algoritmaları Performans Karşılaştırması",*** Journal of Science, Technology and Engineering Research, vol. 2, no. 2, pp. 31-45, Dec. 2021	yes

Nr.	Full Reference of the Publication	Ind. Pub?
37	Badi, H., et al., ***"Efficient and Effective Generation of Test Cases for Pedestrian Detection -Search-based Software Testing of Baidu Apollo in SVL".*** 2021 IEEE Conference on Artificial Intelligence Testing (AITest 2021)	no
38	Santana, J., et al., ***"Evaluating the feasibility of a RISC-V core for real-time applications using a virtual prototype."*** DVCon-US 2022	yes
39	Yayan U., Erdoğmuş A., Karaca M., Çokünlü G., ***"Araç Şaselerinin Kalite Kontrolü için Simülasyon Tabanlı Otonom Endüstriyel Robot Test Sistemi Geliştirilmesi (Development of Simulation based testing for automated robot cell for quality inspection of automotive body-in-white system)",*** TOK 2021, 2 - 04 September 2021, pp.1-6	no
40	Kerem Erdogmus, Alim, and Ugur Yayan. ***"Manipulation of Camera Sensor Data via Fault Injection for Anomaly Detection Studies in Verification and Validation Activities For AI."*** arXiv e-prints (2021): arXiv-2108	yes
41	M. Malik, et al., "***ComFASE: A Tool for Evaluating the Effects of V2V Communication Faults and Attacks on Automated Vehicles,"*** 2022 52nd Annual IEEE/IFIP International Conference on Dependable Systems and Networks (DSN)	no
42	Proença, J. et al., ***"Verification of multiple models of a safety-critical motor controller in railway systems,"*** 4th International Conference on Reliability, Safety and Security of Railway Systems (RSSRAIL2022), June 2022	yes
43	Olthuis, J., Jordão, R., Robino, F., and Borrami, S., ***"VrFy: Verification of Formal Requirements using Generic Traces,"*** 2021 IEEE 21st International Conference on Software Quality, Reliability and Security Companion (QRS-C), 2021, pp. 177-183	yes
44	de la Vara, J. and Morote, J., ***"A Proposal for Model-Based Reliability-Oriented System Design in Industry,"*** 2021 IEEE 21st International Conference on Software Quality, Reliability and Security Companion (QRS-C), 2021, pp. 1153-1154	no
45	Smarra, F., Tjen, J., D'Innocenzo, A., ***"Learning methods for structural damage detection via entropy-based sensors selection."*** Int J Robust Nonlinear Control. 2022; 1- 33	no
46	Agirre, J., et al., ***"The VALU3S ECSEL project: Verification and validation of automated systems safety and security, Microprocessors and Microsystems"***, Volume 87, 2021, 104349	yes
47	Roda-Sanchez, L., et al., ***"Comparison of RGB-D and IMU-based gesture recognition for human-robot interaction in remanufacturing."*** Int J Adv Manuf Technol (2021)	yes
48	Martínez, A., et al., ***"Facial Emotion Recognition from an Unmanned Flying Social Robot for Home Care of Dependent People."*** Electronics 2021, 10, 868	yes
49	de la Vara, J., García, A., Valero, J., et al. ***"Model-based assurance evidence management for safety–critical systems"***. Softw Syst Model (2022)	no

Nr.	Full Reference of the Publication	Ind. Pub?
50	Casino, F., et al., ***"Intercepting Hail Hydra: Real-Time Detection of Algorithmically Generated Domains."*** Journal of Network and Computer Applications. Vol. 190, 2021, p. 1-17. ISSN 1084-8045	no
51	Harmin, D. ***"Advanced Static Analysis of Atomicity in Concurrent Programs through Facebook Infer."***, Brno, 2021. Master's Thesis. Brno University of Technology, Faculty of Information Technology. 2021-06-24. Supervised by Vojnar Tomáš	no
52	Beránek, T. ***"Practical Application of Facebook Infer on Systems Code"***, Brno, 2021. Bachelor's Thesis. Brno University of Technology, Faculty of Information Technology. 2021-06-15. Supervised by Vojnar Tomáš	yes
53	Yazıcı A., Çokunlu G., Özkan M., Tanriseven S., Yayan U., "***Verification and validation methods for Robotic Systems***," 27 July 2021, available online: https://www.youtube.com/watch?v=tM1NSUvrazM	no

Table 2.3. Year 3 publications.

Nr.	Full Reference of the Publication	Ind. Pub?
54	Agirre, J.A., et al., ***"Multidimensional Framework for Characterizing Verification and Validation of Automated Systems"***, 18th European Dependable Computing Conference (EDCC2022), Zaragoza, Spain, 12-15 September, 2022	yes
55	Sedaghatbaf, A., et al., **"DELFASE: A Deep Learning Method for Fault Space Exploration"**, 18th European Dependable Computing Conference (EDCC2022), Zaragoza, Spain, 12-15 September, 2022	no
56	Ferrari, E., et al., ***"Criteria for the Analysis of Gaps and Limitations of V&V Methods for Safety and Security-Critical Systems"***, SAFECOMP 2022: Computer Safety, Reliability, and Security. SAFECOMP 2022 Workshops, LNCS, vol. 13415, pp 35–46, September 6-9, 2022, Munich, Germany	yes
57	Demirci, Z., et al., ***"MARVer: A Tool for Verification of Robotic System's Safety"***, 23rd TURKISH AUTOMATIC CONTROL NATIONAL CONFERENCE, 15-18 September 2022, Elazig, Turkey	no
58	Nandi et al., ***"MARS: a toolset for the safe and secure deployment of heterogeneous distributed systems"***, Real-Time Systems Symposium (RTSS), Explainability of Real-Time Systems and their Analysis, Houston, U.S.A.	yes
59	Saral, M., et al., ***"A safety and security-aware industrial robotic system implementation: ROKOS"***, 23rd Turkish Automatic Control National Conference, 15-18 September 2022, Elazig, Turkey	no

Nr.	Full Reference of the Publication	Ind. Pub?
60	Kırca, Y.S, et al. ***"ROS Based Attack Tool for Verification of Robotic System Security-Submission"***, 23rd Turkish Automatic Control National Conference, 15-18 September 2022, Elazig, Turkey	no
61	Folkesson, et al., ***"On the Evaluation of Three Pre-Injection Analysis Techniques for Model-Implemented Fault- and Attack Injection"***, 27th IEEE Pacific Rim Int. Symposium on Dependable Computing (PRDC2022)	no
62	ter Beek, M.H, et al., **"Can we Communicate? Using Dynamic Logic to Verify Team Automata"**, Proceedings of the 25th International Symposium on Formal Methods (FM 2023)	no
63	Jongmans, S.S. and Proença, J., ***"ST4MP: A Blueprint of Multiparty Session Typing for Multilingual Programming"***, ISoLA 2022, Rhodes, Greece, October 24-28, 2022, LNCS	no
64	M. Maleki and B. Sangchoolie, ***"Simulation-based Fault Injection in Advanced Driver Assistance Systems Modelled in SUMO"***, 17th IEEE Workshop on Silicon Errors in Logic – System Effects, Stanford University, Stanford, California, 2021	no
65	Gaggero, Giovanni Battista, et al. ***"A Framework for Network Security Verification of Automated Vehicles in the Agricultural Domain."***, 2022 26th International Conference Electronics. IEEE, 2022	no
66	M. Maleki and B. Sangchoolie, ***"SUFI: A Simulation-based Fault Injection Tool for Safety Evaluation of Advanced Driver Assistance Systems Modelled in SUMO"***, 17th European Dependable Computing Conference (EDCC), Munich, Germany, 2021	no
67	M. Maleki and B. Sangchoolie, ***"Simulation-based Fault Injection in Advanced Driver Assistance Systems Modelled in SUMO"***, 51st Annual IEEE/IFIP International Conference on Dependable Systems and Networks - Supplemental Volume (DSN-S), Taipei, Taiwan, 2021	no
68	Khan, H.M., et al., ***"Network Failures in Cloud Management Platforms: A study on Openstack"***, CLOSER 2023	no
69	Ozkan, M., et al., ***"Safety Verification of Multiple Industrial Robot Manipulators with Path Conflicts by Model Checking"***, Machines 2023, 11(2), 282	no
70	Guclu, E., et al., ***"An Online Distance Tracker for Verification of Robotic Systems' Safety"***, Sensors 2023, 23(6), 2986	no
71	Kirca, Y.S., et al., ***"Runtime Verification for Anomaly Detection of Robotic Systems Security"***, Machines 2023, 11(2), 166	yes
72	Sheridan, O., Monahan, R., and Luckcuck, M., ***"A Requirements-Driven Methodology: Formal Modelling and Verification of an Aircraft Engine Controller"***, in ter Beek, M.H., Monahan, R. (eds) Integrated Formal Methods. iFM 2022. Lecture Notes in Computer Science, vol 13274. Springer, Cham.	no

Nr.	Full Reference of the Publication	Ind. Pub?
73	Elguea-Aguinaco, I., et al., ***"Goal-Conditioned Reinforcement Learning within a Human-Robot Disassembly Environment"***, Appl. Sci. 2022, 12(22), 11610	no
74	Ivana Stancikova, Ivan Homoliak. ***"SBvote: Scalable Self-Tallying Blockchain-Based Voting"***, proceedings of the 38th ACM/SIGAPP Symposium On Applied Computing (SAC 2023), Tallinn Estonia, March 27 - March 31, 2023	no
75	Fiedor, T., Hruška, M., and Smrčka, A., ***"Orchestrating Digital Twins for Distributed Manufacturing Execution Systems"***, in: Moreno-Díaz, R., Pichler, F., Quesada-Arencibia, A. (eds) Computer Aided Systems Theory – EUROCAST 2022. EUROCAST 2022. Lecture Notes in Computer Science, vol 13789. Springer, Cham	no
76	Farooqui, A., Claase, R.T., and Fabian, M., ***"On Active Learning for Supervisor Synthesis"***, in IEEE Transactions on Automation Science and Engineering, 2022	no
77	de la Vara, J.L., Gallina, B., Fernández-Caballero, A., Molina, J.P., García, A.S., Ayora, C.: ***"Assurance of Software-Intensive Medical Devices: What About Mental Harm?"***, 53rd Annual IEEE/IFIP International Conference on Dependable Systems and Networks (DSN 2023)	no
78	Morote, J., de la Vara, J.L., Giachetti, G., Ayora, C., Alonso, L.: ***"An Industrial Approach for Model-Based Reliability-Oriented System Design"***, 27th IEEE Pacific Rim International Symposium on Dependable Computing (PRDC 2022)	yes
79	Ivana Stancikova, Ivan Homoliak. ***"SBvote: Scalable Self-Tallying Blockchain-Based Voting"***, In proceedings of SAC 2023	no
80	REUSE Company, ***"Traceability Studio User´s Guide"***, 2022, ISBN: 1082350850	yes
81	Giachetti, G., Marín, B., de la Vara, J.L., ***"Mastering Agile Practice Adoption through a Model-Driven Approach for the Combination of Development Methods"*****,** Business & Information Systems Engineering (accepted paper)	no
82	Roda-Sanchez, L., Garrido-Hidalgo, C., García, A.S., ***"Comparison of RGB-D and IMU-based gesture recognition for human-robot interaction in remanufacturing"***, Int J Adv Manuf Technol 124, 3099–3111 (2023)	no
83	Borg, M., Henriksson, J., Socha, K., Ergo, et al., ***"SMIRK is safe: a safety case for a machine learning component in a pedestrian automatic emergency brake system"*****,** Software Qual J (2023)	no
84	Clara Díaz García, ***"Tool for modelling safety standards with multiple views"***, BSc thesis, Grado en Ingeniería Informática, Escuela Superior de Ingeniería Informática, Universidad de Castilla-La Mancha. 2022	no
85	Héctor Fernando Bahamonde Rivera, ***"Assessment of the quality of the text of safety standards with an ontology-based requirements engineering tool"***, MSc thesis, Máster Universitario en Ingeniería Informática. Escuela Superior de Ingeniería Informática, Universidad de Castilla-La Mancha. 2022	no

Nr.	Full Reference of the Publication	Ind. Pub?
86	Pedro Antonio Ramírez de Verger Rodríguez, ***"Graphical assurance case editor for the SACM standard"***, BSc thesis, Grado en Ingeniería Informática, Escuela Superior de Ingeniería Informática, Universidad de Castilla-La Mancha. 2023	no
87	Fryderyk Pryjma, ***"Ux Design In Remote Vechicle Control: Creation Of Usability Guidelines For Remote Control Station Of Vechicles Using Hti Methodology"***, Msc thesis, Faculty of Information Technology and Communication Sciences, Tampere University, June 2022	no
88	Shrishti Trivedi, ***"Using Simulation-Based Testing to Evaluate the Safety Impact of Network Disturbances for Remote Driving"***, MSc thesis, School of Electrical Engineering and Computer Science, KTH Royal Institute of Technology, Sweden, 2023	no
89	Smarra, F., Tjen, J., & D'Innocenzo, A., ***"Learning methods for structural damage detection via entropy-based sensors selection"***, International Journal of Robust and Nonlinear Control, 32(10), 6035-6067	no
90	Proença, J., Edixhoven, L., ***"Caos: A Reusable Scala Web Animator of Operational Semantics"***, in COORDINATION 2023, Held as Part of the 18th International Federated Conference on Distributed Computing Techniques, DisCoTec 2023, Lisbon, Portugal, June 19-23, 2023, Proceedings	no

Based on the publications presented in the previous tables, we have reached the number of 90 accepted publication, which makes Diss-KPI-1 - *"Total number of publications"* successfully achieved. It is however important to make a note regarding publications beyond the duration of the project, as they are mostly likely to be obtained. Project members have still a set of publications being finalized and/or waiting for an acceptance decision; at the time of writing this deliverable, the estimated number of such publications is of 16 (meaning that in the best case, VALU3S will overcome its objective and reach 106 publications in approximately 3 years of activity). The acceptance publications, once communicated, will be taken into consideration, and reported in the project's final review meeting. Moreover, it is indeed natural that even after the project finishes (including the extension period), new publications continue to be prepared and their content being result of work performed in VALU3S. The tracking of such publications will be performed via mandatory acknowledgment and by sending reminders to the project members and may receive support from the Life After VALU3S initiative.

2.2 Publications Web Page and Social Networks Announcements

In order to make the publications resulting from VALU3S activities available and clearly linked to the project, a page that presents the list of publications that were accepted was added to the VALU3S website in the following address: https://valu3s.eu/publications/. In this page, all publications listed satisfy the open access requirements imposed by the legal documents that govern the project (at least

green open access is required). A screenshot of the publications page of the project is presented in Figure 2.1.

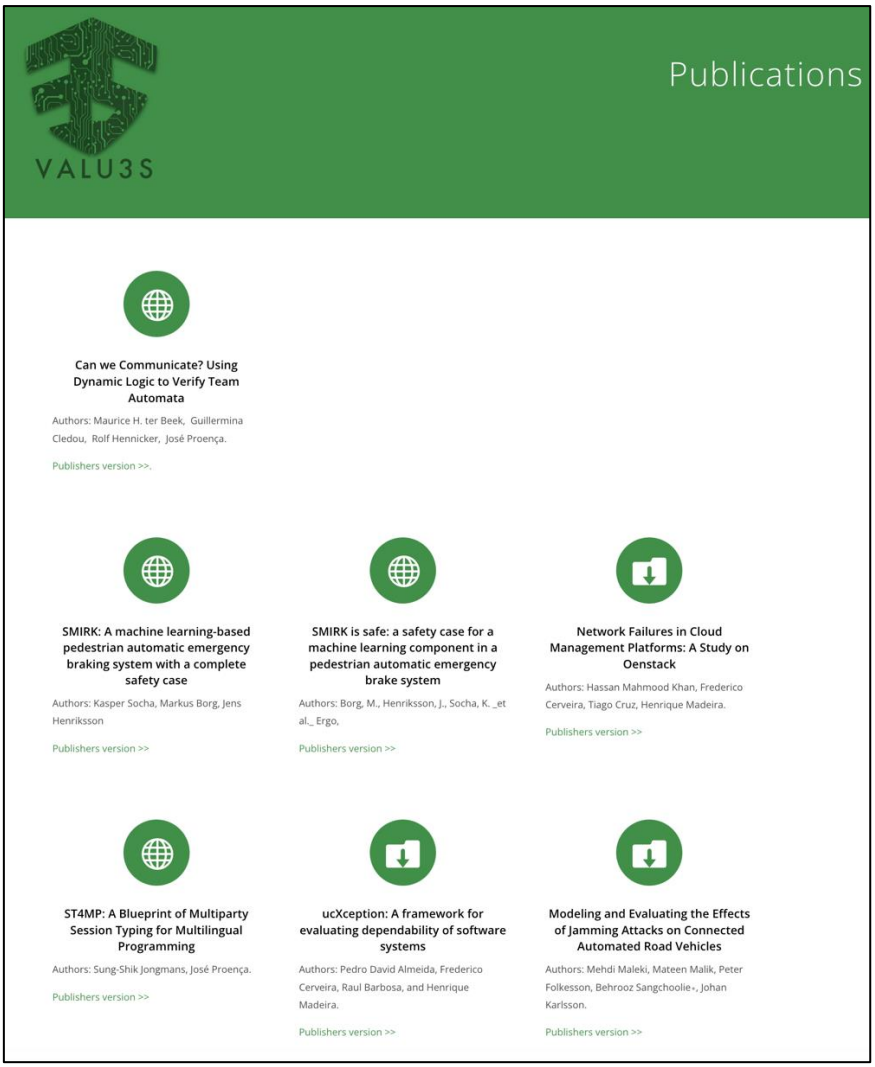


Figure 2.1. VALU3S' website publications page.

Besides having the aforementioned webpage that hosts the publications, VALU3S has also defined a procedure to periodically announce said publications via its social networks, notably in LinkedIn [8] and Twitter [9], and publications are also typically included upon the release of the project's periodic newsletters. In Figure 2.2 and Figure 2.3, we present examples of the typical format of publication announcements in the corresponding social networks. In Figure 2.4 we present the announcement of new publications in one of the project's newsletters (further announcements can be seen in the newsletters page in VALU3S website, available in https://valu3s.eu/newsletters/).

Figure 2.2. VALU3S' publication announcement on LinkedIn.

Figure 2.3. VALU3S' publication on Twitter.

Figure 2.4. VALU3S' publication announcements in newsletter.

2.3 Sponsoring and Organization of Workshops

The second training KPI of VALU3S, Diss-KPI-2 – *"Total number of workshops organized or sponsored by VALU3S"* (see Section 1.2.1) focuses on the efforts of the project in contributing to the organization and/or sponsoring of workshops open to the community. The objective was to be involved in the sponsoring and/or organization of at least 3 workshops along the lifetime of the project. Throughout the project, several members of the consortium were actively involved in this activity, resulting in being involved (or leading) the organization and/or sponsoring of the following workshops:

- ***CPS Segment @ HiPEAC 2022 & HiPEAC 2023:*** the project is one of the sponsoring projects of the *STEADINESS: System Engineering and Dependability in Cyber-Physical Systems* workshop. This is one of the three workshops that make up this segment in the main HiPEAC conference. The 2022 edition of the STEADINESS workshop took place in Budapest, Hungary, on 22-06-2022, while the 2023 edition took place in Toulouse, France, on 17-01-2023. Besides being a sponsor of the STEADINESS workshop, VALU3S members leading WP6 were also in charge of chairing the communication committee of the overall segment.
  Workshop web site (2022): https://www.hipeac.net/2022/budapest/#/program/sessions/7939/
  Workshop web site (2023): https://www.hipeac.net/2023/toulouse/#/program/sessions/8024/
- ***Workshop on Formal Methods for Autonomous Systems:*** workshop series organized by VALU3S partner NIUM focusing on discussing the key difficulties and stimulate collaboration between the robotics and formal methods communities. Each edition of the workshop series included invited speakers, contributed papers, and experience reports. Along the duration of the project, three editions have taken place.
  Workshop web site (2020): https://fmasworkshop.github.io/FMAS2020/
  Workshop web site (2021): https://fmasworkshop.github.io/FMAS2021/
  Workshop web site (2022): https://fmasworkshop.github.io/FMAS2022/

- ***Verification and validation methods for Robotic Systems:*** workshops series co-located with the Turkish Robotics Conference, ToRK, which was organized by VALU3S partners ESOGU. Along the duration of the project, two editions have taken place.
  Workshop web site (2021): https://tork2021.iyte.edu.tr/en/home-page/
  Workshop web site (2022): https://tok2022.firat.edu.tr/

The target of Diss-KPI-2, which aimed at the project organizing and/or sponsoring at least 3 workshops was fully achieved, guaranteeing in this scope the involvement in 7 workshops, to which one must add the organization of a new workshop focused on V&V co-located with a major international conference. Details on this workshop are presented in the next section.

2.4 Organization of VALU3S Workshop on Dependable Cyber-Physical Systems

Besides the support of the project to sponsor relevant workshops, VALU3S has defined as one of its Dissemination & Training KPIs the organization of a workshop focused on the main topic of the project, notably as an opportunity to further increase its visibility and outreach to relevant external stakeholders.

As per recommendation of VALU3S' External Advisory Board members, and after some internal discussions, the decision of the consortium was to organize the workshop co-located with a major scientific conference; the project considered as a move that would clearly benefit the workshop and the project's visibility. While searching for potential venues, we found the 2023's edition of the highly reputed IEEE/IFIP International Conference on Dependable Systems and Networks (DSN 2023 - https://dsn2023.dei.uc.pt/) to be a great venue for this workshop. Another motivation for embracing this opportunity came from the fact that the final review of VALU3S will take place in the scope of that same conference, which together with a VALU3S-organized workshop, builds up to a situation where VALU3S will have a privileged position to promote the value and importance of the V&V-focused work that has been done in the project along the last 3 years, to a large and highly-international audience. The estimation is that 300+ participants will be physically attending DSN in Porto, Portugal, from June 27 to June 30, 2023. The official website of DSN 2023 is shown in Figure 2.5.

Figure 2.5. DSN 2003 webpage.

Having the venue for organizing the workshop identified, the next step was on defining its focus area and name. In what concerns defining the name of the workshop, we have decided that the workshop should be entitled as "Workshop on the V&V of Dependable Cyber-Physical Systems", for which the acronym VERDI was adopted. Regarding the scientific focus of the workshop, we defined that the focus should be V&V methods, techniques, and tools for developing dependable Cyber-Physical Systems (CPSs), in line with the VALU3S mission, but widening its scope to emergent and/or prominent scientific and technological trends such as Deep Learning, Cloud, and Edge Computing, and motivating other application domains beyond those covered in the project. This vision for VERDI is further refined in the workshop's call-for-papers, whose scope we present in Table 2.4, and whose driving topics are presented in Table 2.5.

Table 2.4. VERDI 2023's call-for-papers scope.

VERDI 2023's Scope
Cyber-Physical Systems (CPS) are a class of engineering systems where computation and communication interact with physical processes, providing complex, situation-aware, and often safety-, security-, or mission-critical ecosystems and services. The fast increase and availability of communication bandwidth and computational power, as well as emerging computing paradigms such as Cloud Computing, Edge Computing, and Deep Learning, are pushing forward CPS research and development, and establishing them as promising engineering solutions to address challenges arising in areas as diverse as aerospace, automotive, energy, disaster response, health care, smart farming, manufacturing, city management, among others. A key property that CPS are expected to exhibit is that of dependability, that is, the ability to provide services that can be trusted within well determined time-periods, and equally important, that those service guarantees hold even when the system is subject to faults and attacks. A key ingredient to ensure dependability is thus to successfully apply verification & validation (V&V) techniques and attest the desired levels of safety, security, and privacy. Here V&V refers to the process of determining whether the requirements for a system or component are complete and correct, the products of each development phase fulfil the requirements or conditions imposed by the previous phase, and the final system or component complies with the specified requirements. This is a challenging task that comes with significant time and cost implications for all the organizations involved in the build-up and evaluation of CPS. This challenge becomes even more critical with the incorporation of more and more Artificial Intelligence models into the operational capabilities of CPS for handling tasks that are increasingly complex. The VERDI workshop aims at serving as a discussion forum focused on the area of V&V as a means to guarantee dependability of complex, potentially automated/autonomous CPS.

For VERDI, we defined that both short papers (up to 4 pages) and regular papers (up to 8 pages) will be considered. The submission system adopted was EasyChair and papers could be submitted using the link https://easychair.org/conferences/?conf=dsn2023.

Table 2.5. VERDI 2023's call-for-papers topics.

VERDI's 2023 Topics
The workshop covers all aspects related to the dependability evaluation (with special focus on safety and security) of safety-critical CPS using techniques such as fault/attack-injection, runtime verification, formal verification, semi-formal analysis, simulation, and testing. Topics include, but are not limited to: • Safety/security risk assessment and assurance • Analysis of threats and vulnerabilities • In-the-loop and model-based analysis and assessment • Architecture-driven assurance of safety and security • Interplay between safety and security • Tools for validation and verification • Dependability analysis using simulation and experimental measurement • Methods for qualification, assurance, and certification • Test space exploration and test space pruning • Distributed and real-time monitoring and control • Analysis of probabilistic, real-time, or hybrid systems

Fundamental to the reputation of the workshop, notably since it is its first edition, is the composition of the Program Committee (PC). The approach taken to build this committee was considering a mix of members of the project's consortium, and inviting key researchers and industrialists that have a strong relation with dependability and V&V. The list of members that form VERDI 2023's PC is presented in Table 2.6, where we distinguish who from the PC is also a member from the consortium. In total, 12 out of the total of 31 members are also part of VALU3S's consortium, representing roughly 39% of the total PC members, which the organizers consider as a good balance that provides enough representation of the project in the organization without compromising the involvement of other internationally renowned researchers, which is fundamental to further provide confidence for the venue (notably because it is the first edition of the workshop).

Table 2.6. Members of VERDI 2023's Program Committee.

List of VERDI 2023's Program Committee		
Name	**Institution**	**Member of VALU3S?**
Ahmet Yazici	Eskisehir Osmangazi University, Turkey	YES
Aleš Smrčka	Brno University of Technology, Czech Republic	YES
André De Matos Pedro	VORTEX-CoLab, Portugal	NO
André Lourenço	Cardio ID	YES

List of VERDI 2023's Program Committee		
Antonio Pecchia	Università degli Studi del Sannio, Italy	NO
Barbara Gallina	Mälardalen University, Sweden	NO
Carolyn Talcott	SRI International, USA	NO
Christoph Schmittner	Austrian Institute of Technology, Austria	YES
Guillaume Hiet	INRIA, France	NO
Horst Schirmeier	TU Dresden, Germany	NO
Joseba Andoni Agirre	Universidad Mondragon, Spain	YES
José Bacelar Almeida	University of Minho, Portugal	NO
Jose Luis de la Vara	University of Castilla-La Mancha, Spain	YES
Juan Carlos Ruiz	Universitat Politècnica de València, Spain	NO
Karthik Pattabiraman	The University of British Columbia, Canada	NO
Marcello Cinque	Universit di Napoli Federico II, Italy	NO
Marie Farrell	The University of Manchester, United Kingdom	NO
Martin Törngren	KTH Royal Institute of Technology, Sweden	NO
Maurizio Mongelli	CNR-IEIIT, Italy	NO
Nasser Nowdehi	Volvo AB, Sweden	NO
Paolo Lollini	University of Firenze, Italy	NO
Peter Folkesson	RISE, Sweden	YES
Peter Ölveczky	University of Oslo, Norway	NO
Peter Popov	City University, United Kingdom	NO
Rosemary Monahan	Maynooth University, Ireland	YES
Raul Barbosa	University of Coimbra, Portugal	YES
Stefano Tonetta	FBK-ICT, Italy	YES
Stylianos Basagiannis	Collins Aerospace, Ireland	YES
Thomas Bauer	Fraunhofer, Germany	YES
Tomas Olovsson	Chalmers University of Technology, Sweden	NO
Volker Stolz	Høgskulen på Vestlandet, Norway	NO

In what concerns the dissemination of the workshop, the approach was to develop a website for it, which is presented in Figure 2.6 (official address being https://verdi-workshop.github.io/2023/), and link the website to DSN 2023's specific webpage for co-located workshops as shown in Figure 2.7 (see https://dsn2023.dei.uc.pt/calls_cfw-workshop_contributions.html) and VALU3'S official website (see https://valu3s.eu/verdi-workshop/). Besides the website, internal communication was used to motivate partners of the project to submit papers and to use their research/industrial connections and networks with affinity to the scope and topics of VERDI, to submit research papers. Several EU funded projects were also contacted (beyond those for which VALU3S holds a liaison relation). Moreover, both specific

mailing lists typically used by the V&V community for scientific discussion and dissemination, as well as more generalist call-for-papers announcement mailing lists received the VERDI's announcement.

Figure 2.6. VERDI 2023's official webpage.

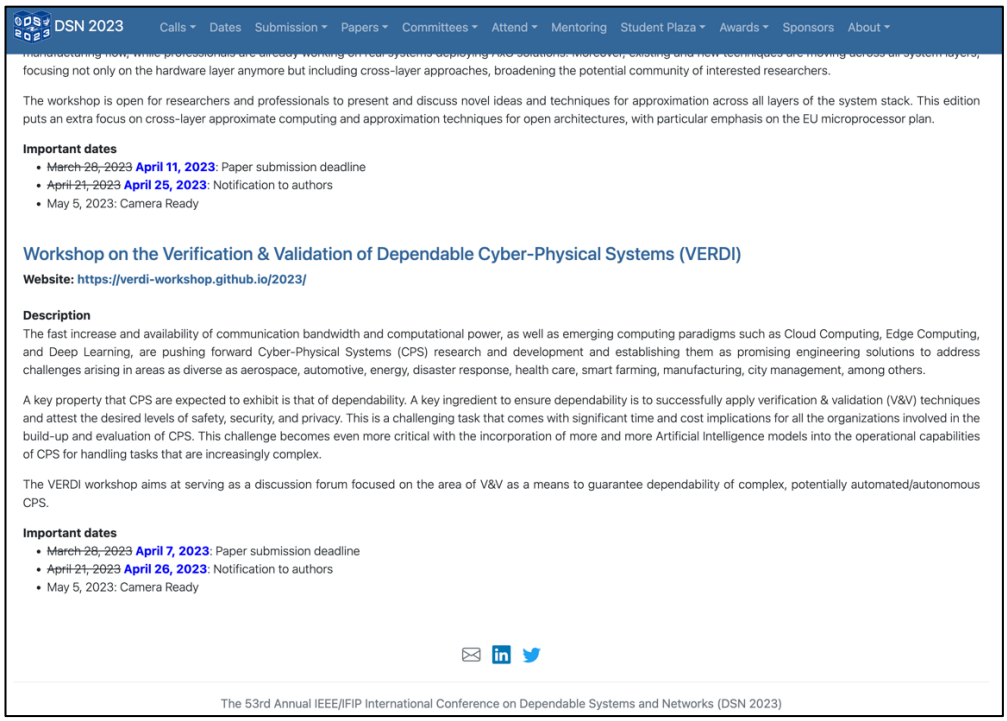


Figure 2.7. VERDI's entry in DSN 2023's sub-webpage dedicated to workshops.

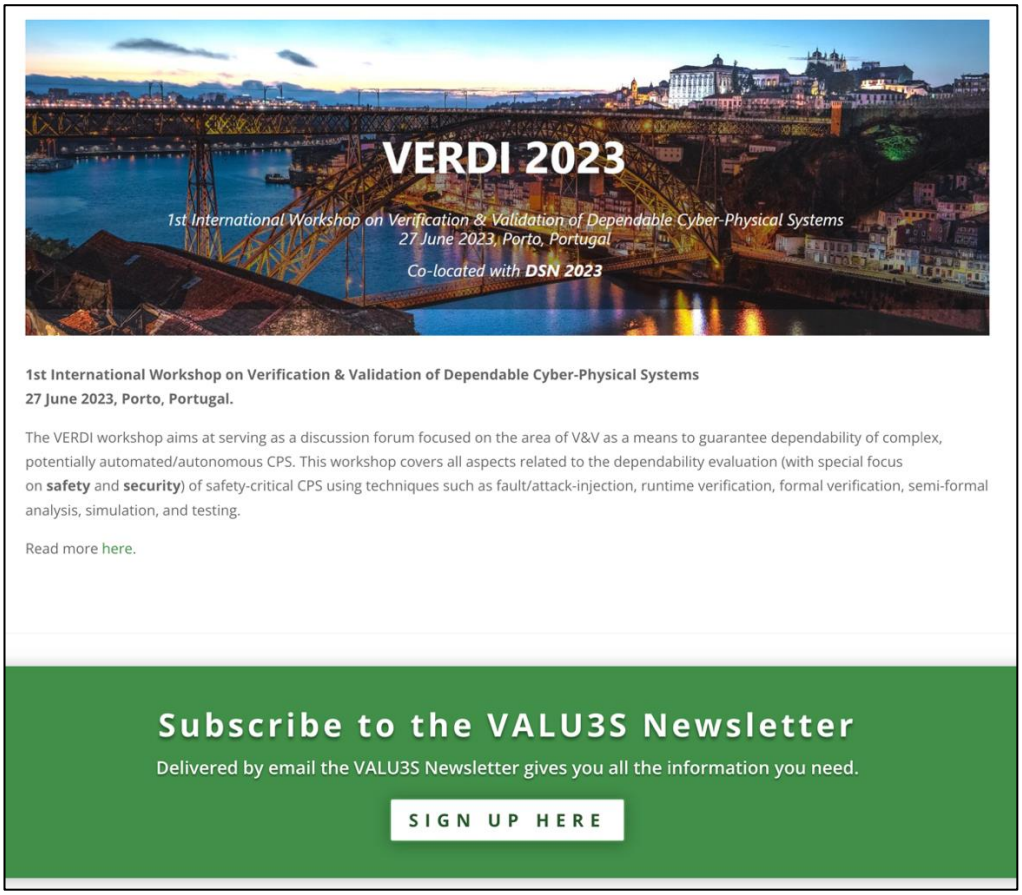


Figure 2.8. VERDI 2023's entry in VALU3S official website.

At the time of preparing this deliverable, the submissions period had already finished, and VERDI ended up receiving 24 submissions, which we can consider a success given that it is indeed the first edition of the workshop. Moreover, it also allows to conclude that co-locating VERDI with a highlight global conference on dependable systems and networks was the right move towards achieving this number of submissions. Currently, it is ongoing the paper evaluation stage.

Moreover, currently we have already confirmed two keynotes on distinct topics: a first one, by Karthik Pattabiraman (Professor of Electrical and Computer Engineering at the University of British Columbia, USA) focusing on Fault Injection; a second one by José Bacelar Almeida (Professor of Computer Science at the University of Minho, Portugal) focusing on high-assurance cryptography.

2.5 Open-Source Results

Another key activity framed within the dissemination activities of the project is related to the open-source developments resulting from activities of the project, and that are considered in Diss-KPI-3 – *"Total Number of VALU3S results made available as open-source projects"* (see Section 1.2.1) whose target is to achieve 15 open-source projects until the end of the project. In this section we present all the open-source projects developed within the project; each such project is presented as a table, and each of the table describes the partner(s) responsible by the result, the name of the results, its website address for external access, related VALU3S use case, and associated license. Moreover, we also associate the V&V method(s) to the results so that they align with the classification established in VALU3S, which are revisited in Table 2.7.

Table 2.7. Acronyms of V&V methods considered in open-source projects, according to D3.1 [7].

List of V&V methods associated with open-source results produced in VALU3S	
ACS Assessment of Cybersecurity-Informed Safety	**ATG** Automatic test generation
BDO Bi-directional On-chip-instrument-interface OCII	**CPU** CPU Verification
DAC Dynamic analysis| Extended Dynamic Analysis of Concurrent Programs	**FDD** Failure Detection and Diagnosis (FDD) in Robotic Systems
FIF Fault-Injection in FPGAs	**SFM** Formal Requirements-Driven Verification
GFV General Formal Verification	**HIS** Human Interaction Safety Analysis
IFI Interface fault injection	**IDS** Intrusion Detection for WSN based on WPM State Estimation

List of V&V methods associated with open-source results produced in VALU3S	
KFB Kalman Filter-Based Fault Detector	**KCQ** Knowledge-centric system artefact quality analysis
KCT Knowledge-centric traceability management	**MLV** Machine Learning Model Validation
MCH Model Checking	**MCF** Model Checking Families of Real Time Specifications
MHS Model Checking of Hybrid Systems	**MAC** Model-based assurance and certification
MBF Model-Based Formal Specification and Verification for Robotic Systems	**MSA** Model-Based Safety Analysis – Failure Logic Analysis
MBT Model-Based Testing	**MTA** Model-Based Threat Analysis
MIA Model-Implemented Attack Injection	**MIF** Model-Implemented Fault Injection
DMD Penetration Testing	**RTC** Remote testing capabilities
RAS Risk analysis	**RPF** Rule-based prediction of faults
RVF Runtime Verification Based on Formal Specification	**SCR** Safety case re-use
SAI Simulation-based Attack Injection at System-level	**SFI** Simulation-based Fault Injection at System-level
SBV Simulation-based Robot Verification	**SBT** Simulation-based testing for human-robot collaboration
STE Smart test evaluation database	**FIN** Software implemented fault injection
SAN Source Code Static Analysis	**TCG** Test Case Generation from Meta-Language
TOS Test optimization for simulation-based testing of automated systems	**TPA** Test Parallelization and Automation

List of V&V methods associated with open-source results produced in VALU3S	
VVM V&V of machine learning-based systems using simulators	**VUR** Virtual & augmented reality-based user interaction V&V and technology acceptance
VAD Virtual Architecture Development and Simulated Evaluation of Software Concepts	**VAC** Vulnerability Analysis of Cryptographic Modules Against Hardware-Based Attacks
VAI Vulnerability and attack injection	**WIN** Wireless interface network security assessment

The currently available open-source results are presented from Table 2.8 to Table 2.22.

Table 2.8. The Uppex open-source project.

Partner	Project Name	Associated Method(s)	URL	Use Case(s)	License
ISEP	Uppex	MCF	https://github.com/cister-labs/uppex	UC10	MIT
Short Description: Uppex is a tool that supports the parameterization of Uppaal models, and the management of families of different configurations.					

Table 2.9. The SUFI open-source project.

Partner	Project Name	Associated Method(s)	URL	Use Case(s)	License
RISE	SUFI	SAI, SFI	https://github.com/RISE-Dependable-Transport-Systems/SUFI	UC2	GPL-3.0
Short Description: SUFI is a SUMO-based fault and attack injector tool. The tool combines SUMO and Python, where SUMO is used for mobility simulation, where traffic scenarios and vehicle features are defined. On the other hand, Python facilitates the definition of scripts for different fault models and selecting fault locations and fault durations. SUMO and Python are communicating via TraCI.					

Table 2.10. The Plogchecker open-source tool.

Partner	Project Name	Associated Method(s)	URL	Use Case(s)	License
BUT	Plogchecker	RVF	https://pajda.fit.vutbr.cz/testos/plogchecker	UC1, UC2	GPL 3.0
Short Description: The tool for checking various log files (text-based) for violation and/or satisfaction of properties, i.e., specification of correct or incorrect sequences of logged actions.					

Table 2.11. The SMIRK open-source tool.

Partner	Project Name	Associated Method(s)	URL	Use Case(s)	License
RISE	SMIRK	RAS	https://github.com/RI-SE/smirk/	UC1	MIT
Short Description: SMIRK is an experimental pedestrian emergency braking ADAS facilitating research on quality assurance of critical components that rely on machine learning. The repository includes a complete safety case for the machine learning component based on the AMLAS framework.					

Table 2.12. The SRVT open-source tool.

Partner	Project Name	Associated Method(s)	URL	Use Case(s)	License
IMTGD	SRVT	SBV	https://github.com/inomuh/srvt-ros	UC11	Apache 2.0
Short Description: SRVT can be thought of as a toolkit or advanced method that allows a robotic system to be imported into a simulation environment and applied to validation tests. The basis of the system is the coordinated use of some critical software for the ROS ecosystem. Simulation environment using Gazebo, trajectory planning using Moveit, mission communication and dynamic verification system using ROS Smach package were built in a single ROS package.					

Table 2.13. The CamFITool open-source tool.

Partner	Project Name	Associated Method(s)	URL	Use Case(s)	License
IMTGD	CamFITool	SFI	https://github.com/inomuh/camfitool	UC11	Apache 2.0
Short Description: Camera Fault Injection Tool (CamFITool) enables state-of-art fault injection methods to RGB and TOF cameras in order to perform verification and validation activities on robotic systems. This fault injection tool is written in Python and Qt5 for the interface. The CamFITool is also ROS Noetic compatible.					

Table 2.14. The IMFIT open-source tool.

Partner	Project Name	Associated Method(s)	URL	Use Case(s)	License
IMTGD	IMFIT	SFI	https://github.com/inomuh/imfit	UC11	Apache 2.0
Short Description: IM-FIT provides ways to find the weaknesses on Python and ROS. The user can use IM-FIT with workload and/or code snippets. At the same time, the user can create custom workload and code snippets for its codes. The codes scanned by IM-FIT to detect the lines. The user can select the lines to use for execution. The user can select what features to run at the execution module. The user can show pieces of information about his/her tested codes. If the user wants to watch the created scenarios by IM-FIT, he/she can do it on Gazebo.					

Table 2.15. The ucXception open-source tool.

Partner	Project Name	Associated Method(s)	URL	Use Case(s)	License
COIMBRA	ucXception	FIN	https://github.com/ucx-code/ucXception	UC14	BSD 3-clause
Short Description: ucXception is a framework for conducting fault injection campaigns in various systems, including virtualized and cloud systems. It includes three different fault injection tools and is able to emulate hardware and software faults.					

Table 2.16. The Unity open-source tool.

Partner	Project Name	Associated Method(s)	URL	Use Case(s)	License
ESTE	Unity	SCT	https://github.com/ThrowTheSwitch/Unity	UC6	MIT
Short Description: Perform Unit Test on target (SUT) sending feedback report to execution environment (PC).					

Table 2.17. The Scenario Generator open-source tool.

Partner	Project Name	Associated Method(s)	URL	Use Case(s)	License
INFOTIV	Scenario Generator	VVM	https://github.com/ebadi/ScenarioGenerator/	UC1	BSD 3-clause
Short Description: ScenarioGenerator performs search-based software testing of Baidu Apollo by automatic generation of various traffic scenarios in SVL end-to-end autonomous vehicles, to verify and validate the safety functionality of Apollo autonomous systems.					

Table 2.18. The ComFASE open-source tool.

Partner	Project Name	Associated Method(s)	URL	Use Case(s)	License
RISE	ComFASE	SAI, SFI	https://github.com/RISE-Dependable-Transport-Systems/ComFASE	UC2	GPL 3.0
Short Description: ComFASE is a communication fault and attack simulation engine. ComFASE is used to identify and evaluate potentially dangerous behaviours of interconnected automated vehicles in the presence of faults and attacks in wireless vehicular networks. ComFASE is built on top of OMNET++ (a network simulator) and integrates SUMO (a traffic simulator) and Veins (a vehicular network simulator). The tool is flexible in modelling different types of faults and attacks and can be effectively used to study the interplay between safety and cybersecurity attributes by injecting cybersecurity attacks and evaluating their safety implications.					

Table 2.19. The Netloiter open-source tool.

Partner	Project Name	Associated Method(s)	URL	Use Case(s)	License
BUT	Netloiter	SFI	https://pajda.fit.vutbr.cz/testos/netloiter	UC1, UC2	GPL 3.0

Short Description: NetLoiter is a tool for testing network applications consisting of multiple nodes communicating with each other via IP protocol. The tool is based on the method of software implemented fault-injection (SWIFI) and supports different types of faults, attacks, and fault-injection scenarios manipulating IP packets. NetLoiter can simulate network faults like packet delays, loss of communication channel, various types of jitter, and attacks based on the man-in-the-middle (MITM) attacks such as rerouting packets, payload change, or tailored attacks configured dynamically based on higher-level (application-specific) communication protocols. The tool can be applied to all kinds of applications communicating via IPv4 or IPv6 stack.

Table 2.20. The uRA-TLS13 open-source tool.

Partner	Project Name	Associated Method(s)	URL	Use Case(s)	License
ISEP	uRA-TLS13	MCF	https://bitbucket.org/mars-language/ura-tls13/src/master/	UC14	GPL 2.0
Short Description: The micro-ROS Agent (μRA) is a server that connects micro-ROS Clients (μRCs) to a DDS Domain. The μRA acts on behalf of the μRCs by publishing on the DDS domain messages the μRC wanted to publish, and forwarding to the μRC messages related to the topics μRC subscribes. This repository goes through the steps to compile and run a μRA using our custom transport based on TLS 1.3.					

Table 2.21. The DELFASE open-source tool.

Partner	Project Name	Associated Method(s)	URL	Use Case(s)	License
RISE	DELFASE	SAI, SFI	https://github.com/alisedaghatbaf/DELFASE	N/A	GPL 2.0
Short Description: DELFASE is a deep learning method for fault space exploration that takes advantage of Generative Adversarial Networks (GANs) and an active learning technique called ranked batch-mode sampling to identify critical faults.					

Table 2.22. The CarFASE open-source tool.

Partner	Project Name	Associated Method(s)	URL	Use Case(s)	License
RISE	CarFASE	SAI, SFI	https://github.com/RISE-Dependable-Transport-Systems/CarFASE	N/A	GPL 2.0
Short Description: CarFASE (Carla-based Fault and Attack Simulation Engine) is developed to automate the evaluation of safety attributes of autonomous driving stacks (OpenPilot) by injecting faults and attacks into the AD stack and evaluating its impact in a simulated environment (Carla).					

Currently, there are already 15 open-source developments produced inside VALU3S and available to the external communities, meaning that we have successfully achieved the value establish for Diss-KPI-3. It is however expected that the number increases, since some partners are still finishing the necessary developments so that these are matured enough to be released to the public.

Chapter 3 Training Activities

In this chapter, we report on the results involving training activities. These refer mostly to internal training activities within the consortium, but training activities targeting external audiences are also presented, namely in what concerns the summer school that is being organized by the project. Training was a continuous activity that has been implemented early in VALU3S and that has been very well received by the whole consortium.

3.1 Training Materials Developed

During the project, several training materials were developed, most of them in the form of video content or documentation associated with the open-source tools generated in the scope of the project, which have been already reported in Section 2.5 and as will be described in Section 3.2.

To measure the performance of training material produced, we have defined Train-KPI-1 – *"Total number of training materials developed by the project"*, which established that VALU3S aimed at providing 25 training materials. The consortium has produced a total of 87 items that can be considered training materials based on the already mentioned criteria, thus achieving and going beyond the target established by Train-KPI-1. These 87 items are the sum of the training materials embedded in the open-source repositories, which amount to 16, and 71 videos (including the training sessions and the short videos on use cases and tools).

We also want to note that the number of training materials will increase due to the organization of the Summer School on the Verification and Validation of Dependable Cyber-Physical Systems, to be organized with the support of VALU3S, during July 2023, in Genova, Italy. At the time of preparing this deliverable, the school proposes a set of 12 different classes/modules, and for each of them new materials will be produced (e.g., presentations slides, auxiliary technical documents, or even exercises if applicable).

3.2 Training Sessions

Since the first year, VALU3S has put efforts in planning and implementing a track of internal training sessions. The goal of this training was, initially, to increase the awareness of consortium members regarding methods and tools being addressed in the project. In the second year and given the relevance of standardization in the project activities, the consortium engaged on specific training sessions focused on standards relevant to the project. Henceforth, during the second year of the project, and part of the third and last year, most of the training activities had their focus on standards.

All training sessions were recorded and, afterwards, made available in the project's website [6] and in the project's YouTube channel [10]. They were also periodically announced on the project's social networks [8,9]. The total number of times that the videos focused on methods and tools have been

watched has reached already the 2824 (out of which 1700 are visualizations of the session entitled *"Simulating Traffic Scenarios Using CARLA"*). In what concerns the views of the training sessions focused on standardisation, up to moment of writing this report, the number of visualizations has reached 865.

The list of training sessions that took place during the project is presented in Table 3.1. With these sessions, the project reached the goal of organizing 18 training sessions, meaning that the established Train-KPI-2 – *"Total number of internal training sessions"*, whose target value was defined to be 6, has been successfully achieved (this happened already during the second year of the project).

Table 3.1. List of training sessions that took place during the project.

VALU3S Partner	Speaker(s)	Title of the Training	Date
UNIGE, ISEP, STAM, RISE	Fabio Patrone, Giann Nandi, José Proença, Davide Ottonello,	VALU3S First Training Session (part 1) This session included the following contents: • Wireless Interface Network Security Assessment https://www.youtube.com/watch?v=0Gq2DzeicJo&t=1s • Runtime Verification Based on Formal Specifications https://www.youtube.com/watch?v=cMripFJ-bB4 • Risk Analysis for Secure Automated Systems https://www.youtube.com/watch?v=NVIrKQ4IxF4 • Introduction to Model Checking https://www.youtube.com/watch?v=tU_aOytuqLg • Simulation-based fault and attack injection at system level, Mateen Malik, https://www.youtube.com/watch?v=OH6HeHP5j0U	March 25, 2021

VALU3S Partner	Speaker(s)	Title of the Training	Date
FRAUNHOFER, INFOTIV, RISE, UCLM, INTECS, NUIM	Thomas Bauer, Hamid Ebadi, Peter Folkesson, Jose Luis la Vara, Silvia Mazzini, Marie Farrel	VALU3S First Training Session (part 2) This session included the following contents: • Virtual Architecture Development and Simulated Evaluation of Software Components with FERAL https://www.youtube.com/watch?v=YMHFFRsnI3s • Simulating Traffic Scenarios Using CARLA https://www.youtube.com/watch?v=erbDz5Djk_c • Model-Implemented Fault and Attack Injection https://www.youtube.com/watch?v=HfTzYSVclXM • Model-Based Assurance and Certification https://www.youtube.com/watch?v=Y90FbYz4NaM • Model-Based Failure Logic Analysis https://www.youtube.com/watch?v=RYOVpTL6dso • An Introduction to Formal Specification and Verification https://www.youtube.com/watch?v=FQGKbYCbxPY	April 22, 2021
IMGDT, ESOGU	Ugur YAYAN, Mustafa Karaca, Ahmet Yazıcı, Metin Özkan	Use Case 11: Automated robot inspection cell for quality control of automotive body- in-white; Tools and methods for the partners. Day 1: ROS Basics, GAZEBO + Moveit Basics. Day 2: IMFIT, SRVT, Formal Methods for V&V of Robotic Systems, Model Checking Tools; UPPAAL, PRISM, Runtime Verification; ROSMonitoring, 3D Environment Modelling.	June 16-18, 2021
RGB	Ricardo Ruiz	CEN ISO/IEEE 11073: Health informatics - Medical / health device communication standards YouTube Link: https://www.youtube.com/watch?v=7jYzd9oO680&t=35s	September, 16, 2021
AIT	Rupert Schlick, Christl Korbinian	ThreatGet Training Session (Focus on UC1)	November, 15, 2021

VALU3S Partner	Speaker(s)	Title of the Training	Date
AIT	Christoph Schmittner	ISO/SAE 21434: Road vehicles - Cybersecurity engineering & ISO/DPAS 5112: Road vehicles - Guidelines for auditing cybersecurity engineering. YouTube Link: https://www.youtube.com/watch?v=J1mzZpVgNkM&t=4s	December, 16, 2021
AIT	Christoph Schmittner	ISO 26262: Road vehicles - Functional safety & ISO/PAS 21448 Road vehicles - Safety of the intended functionality (Short overview only). YouTube Link: https://www.youtube.com/watch?v=7jYzd9oO680&t=35s	January, 20, 2022
UTRC	Stylianos Basagiannis, George Giantamidis	DO-178C: Software Considerations in Airborne Systems and Equipment Certification & DO-333: Formal Methods Supplement to DO-178C . YouTube Link: https://www.youtube.com/watch?v=ZFVK7xZH6fM&t=12s	February, 25, 2022
AIT	Christoph Schmittner	ANSI/UL 4600: Standard for Safety for the Evaluation of Autonomous Products YouTube https://www.youtube.com/watch?v=4CcOJUX2aGU&t=1s	March, 08, 2022
BUT	Ivan Homoliak	Application of ISO/IEC 15408 standard for IT Security Evaluation YouTube Link: https://www.youtube.com/watch?v=-gzLaktxMmQ&list=PLGtGM9euw6A66ceQbywXGjVoTKEhP-Of7&index=19	April, 14, 2022
NUIM	Marie Farell	Evolution of IEEE P7009 Standard Towards Fail-Safe Design of Autonomous System YouTube Link: https://www.youtube.com/watch?v=ef1Nv5S7DTY&list=PLGtGM9euw6A66ceQbywXGjVoTKEhP-Of7&index=20	

VALU3S Partner	Speaker(s)	Title of the Training	Date
ESTE	Carlo Ferraresi, Emanuele Mingozzi	ISO 25119 Tractors and machinery for agriculture and forestry YouTube Link: https://www.youtube.com/watch?v=E_wkIQr19VY&list=PLGtGM9euw6A66ceQbywXGjVoTKEhP-Of7&index=21	October 12, 2022
ESOGU	Ahmet Yazici, Metin Ozkan	ISO 10218-2_2011 – Robots and robotic devices - Safety Requirements for Industrial Robots YouTube Link: https://www.youtube.com/watch?v=omTXSI7KZ10&list=PLGtGM9euw6A66ceQbywXGjVoTKEhP-Of7&index=22	November 11, 2022

3.2.1 Satisfaction Questionnaires

To evaluate the satisfaction of the project partners regarding the training sessions organized, we have conducted satisfaction surveys: i) a first questionnaire focused on the satisfaction of partners about the first two training sessions, which were focused on V&V methods and tools, and that took place during the first year of the project; ii) a second satisfaction survey focused on the first round of training sessions on standardization. Given the fact that, after the second round of training focused on standards, the project was getting closer to its end, and given that there was a decision to move efforts to the organization of VALU3S workshop and VALU3S summer school, the consortium decided not to pursue more internal training sessions, and thus no further satisfaction questionnaires were prepared and released.

Satisfaction regarding the training sessions on V&V methods and tools

In both parts of the first VALU3S training session, it became clear the interest of several partners in the presented contents, notably in what concerns getting detailed understanding of the presented contents and also in understanding the possibility of applying some of the methods in use cases and in combining them with other methods being addressed in the project. Regarding more general comments, the partners that attended these sessions essentially showed contentment for having the opportunity to attend to the classes, some suggesting that a higher-level presentation with more examples showing the applicability of the presented content in concrete use cases would benefit the sessions.

First satisfaction questionnaire on standardization training sessions

Since during the second year and a part of the third year of the project, the training sessions changed their focus to standardization. This was a decision mostly motivated by the need of the project to contribute to the goal of influencing ongoing standardization activities in standards that are closely related to the project's topics and activities. It was therefore relevant for the organizers of the training to have a good idea of the impact of those sessions in the partners, namely to what extent these sessions could motivate and/or support partners to get involved in standardization activates. To evaluate this, a satisfaction questionnaire was produced and distributed by the VALU3S consortium to gather their

perspective about the usefulness and importance of the sessions from their point-of-view. The questionnaire includes 14 questions divided into three sections: i) participant identification, ii) training session attendance, and iii) attendee's satisfaction with the training sessions.

Between the 13th and the 22nd of April 2022, 22 partners from 11 different companies/institutions responded to the above-described survey. The analysis of their responses indicates a great interest of the partners in topics related to road vehicles' security and safety. Presentations about standards ISO/SAE 21434 [1] and ISO 26262 [2] were the ones with the most replying attendees and the ones chosen as most relevant overall with 54% and 50% of the votes, respectively, followed by ISO/PAS 21448 [3] with 45%.

When asked about the reason behind their choices of most relevant sessions, 50% of the partners said that they had previous interest in the respective standard but never got the chance to dive further into it. The remaining 41% said that the respective standard was directly linked to their use case inside the project, and 9% said that they did not know about the respective standard, but the training session provided a new perspective for their activities.

Regarding the amount of information presented during the training sessions, 90% of the partners said that enough information was provided, while 10% said more details could have been presented. No partner indicated that the training sessions did not display enough information. Despite the introductory character of the sessions, 82% of the partners said that they learned something new from standards that they were already familiar with, 9% said that they did not learn anything new, and 9% said that they were not familiar with any of the standards.

When it comes to the impact of the training sessions on the interactions between project members, 27% of the partners said that they identified contacts for new collaborations. On top of that, 22% of the partners indicated that they could potentially contribute to future training sessions on topics involving other standards, safety, and medical landscapes.

To conclude, partners indicated that their level of satisfaction was 4.33 on a scale from 0 to 5. Besides the supportive comments left at the end of the questionnaire, suggestions like "having a regular set time for the standards training would help so that attendance would be easier" and "sometimes the introduction was a bit too lengthy".

3.3 VALU3S Summer School

A final objective that needs to be reported is the initiative of the consortium in what concerns the organization and implementation of a summer school. This indeed corresponds to one of VALU3S' training KPIs of task 6.1, Train-KPI-4 – *"Organization of summer or winter schools"*.

A subset of members of VALU3S have engaged in such endeavour and, at the time or writing this report, this groups has already defined the location and dates for the event, and proposed a baseline set of core topics that will be transformed into classes to be offered. The summer school's target audience is mainly

bachelors, masters, PhD students, but also industry early-stage researchers/engineers that may have an interest in expanding their know-how on relevant topics of V&V that have been considered in VALU3S.

In terms of organization, the summer school will take place in Genova, Italy, with the support of the partners within the Italian cluster. The summer school timeline is from the 18th of July to the 20th of July 2023. The estimated cost for registration (per participant) is around 180€, which we believe to be an attractive amount for the interested applicants, allowing them to save on registration costs and possibly use that budget slack for travel and accommodation costs.

Regarding the scientific/technological contents considered for lectures in the summer school, the organizing team adopted as basis the classification of V&V methods adopted by VALU3S that was reported in deliverable D3.1 [7]. This originated 6 modules focused on a high-level classification, which are then split into specific classes, which are presented below. For each of the defined modules, the organizing team has identified the individual members of the consortium whose background, professional activity, and contributions given to the project form a combination that makes them the more suited candidates to develop and teach the classes in the summer school. At the moment of writing this deliverable, these members have proposed concrete names for the classes of each of the modules and defined (even if at a higher-level for now) the target contents to be taught. In more detail, the modules and the classes that compose them are the following:

- **Introduction to V&V:** module composed of one lecture, entitled *"Introduction to verification and validation of dependable cyber-physical systems"*, with the duration of 1h30m, devoted to introducing the relevance of V&V methods, techniques, and tools for the development of dependable CPSs.
- **Testing:** module composed of three classes, each with the duration of 1h30m, devoted to cover methods based on testing, including injection-based V&V. The classes are the following:
    - *"An overview to Testing of safety-critical cyber-physical systems"*
    - *"Simulation-based fault injection"*
    - *"Software-implemented fault injection"*
- **Formal Verification**: module formed by four classes, each with the duration of 1h30m, devoted at covering some of the formal verification methods and techniques. The classes are the following:
    - *"Formal Requirements Engineering"*
    - *"Introduction to Model checking"*
    - *"Symbolic Model Checking of Hybrid Systems"*
    - *"Deductive Verification in a Nutshell"*
- **Verification and validation modelling language (VVML):** module composed of one class, entitled *"VVML: Specifying Workflows for V&V Methods"*, which will focus on the introduction to, and usage of the VVML modelling language.
- **VALU3S web-based repository:** module formed by one class entitled *"A V&V framework for storing elements of V&V activities"*, with a duration of 1h30m, and which will focus on the VALU3S web-based repository, its contents and purpose, and on how it can bring benefits for those stakeholders.

- **Standards and standardisation initiatives:** module formed by two classes, each with the duration of 1h30m and entitled *"An overview of relevant safety and cybersecurity standards"*, focused on introducing standards relevant for being employed in the development of dependable CPSs.

Regarding the individual members of the VALU3S consortium that compose the list of people involved in defining the concrete classes, and that are the candidates for teaching them, is presented in Table 3.2.

Table 3.2. List with identified lecturers and contributes for summer school classes.

VALU3S member	Module
Behrooz Sangchoolie, RISE	Introduction to V&V
David Pereira (ISEP), José Proença (ISEP), José Luis de la Vara (UCLM), Raul Barbosa (COIMBRA), Rosemary Monahan (NUIM), Stefano Tonetta (FBK)	Formal Verification
Behrooz Sangchoolie (RISE), Frederico Cerveira (COIMBRA), Thomas Bauer (Fraunhofer IESE)	Testing
Bohumil Hruška (LieberLieber), José Proença (ISEP), Robert Sicher (Lieberlieber), Thomas Bauer (Fraunhofer IESE)	VVML
Joseba Agirre, MGEP Raul Barbosa, COIMBRA	VALU3S web-based repository
Christoph Schmittner, AIT Pierre Kleberger, RISE Sina Borrami, ALSTOM Jonas Melchert, ALSTOM	Standards

Regarding the actual schedule for the summer school, a preliminary version has been already defined with the supported by the local organizing team of the Italian cluster, has also been defined and is presented in Table 3.3. We consider important to note that, besides the classes per se, the summer school will also provide time slots for project use cases to be advertised to the participants and for the participants to present posters about the work that they are doing. We believe that these specific sessions will help networking between participant students, lecturers, and the representatives of the use cases of VALU3S, creating therefore an environment where students can obtain relevant insights about the applicability of results produced within the project and possibly identify collaboration opportunities.

Table 3.3. Current tentative schedule of the summer school.

Hours/Days	Tuesday 18th	Wednesday 19th	Thursday 20th
9h00 - 10h30	Introduction to V&V of dependable cyber-physical systems	VVML: Specifying Workflows for V&V Methods	Symbolic Model Checking of Hybrid Systems
10h30 - 11h00	Break	Break	Break
11h00 - 12h30	An overview to testing of safety-critical cyber-physical systems	Formal Requirements Engineering	Deductive Verification in a Nutshell
12h30 - 14h00	Lunch & Posters Presentations	Lunch & Posters Presentations	Lunch & Posters Presentations
14h00 - 15h30	Software-implemented fault injection	Introduction to Model Checking	An overview of relevant safety and cybersecurity standards
15h30 - 16h00	Break	Break	Break
16h00 - 17h30	Simulation-based fault injection	A V&V framework for storing elements of V&V activities	An overview of relevant safety and cybersecurity standards

To finalize the reporting on the initiative of the summer school organization, we now focus on dissemination of the event. Currently, the advertisement has been performed mostly internally since the plan is to motivate the consortium entities to identify internal members to whom participating in the summer school could be highly beneficial to their careers. Hence, we are talking about final stage BSc and MSc students, as well as PhD students on the side of academic entities, whereas for the industrial partners, your engineers working on V&V are the target audience within the project consortium. External dissemination is mostly being taken care via contact networks of the project partners, as well as the project web page (see Figure 3.2) and announcements in the project's latest edition of the newsletter (see Figure 3.1).

VALU3S is organizing a summer school!

The VALU3S project is proud to organize a summer school with the focus on the results produced during the project.

The theme of the school is Verification and Validation of Dependable Cyber-Physical Systems, and the following topics are planned to be covered, each in 1-to-3-hour modules:

- Testing (e.g., injection-based verification and validation)
- Simulation
- Formal Verification (e.g., requirements formalization, Model checking, semi-formal analysis, including Risk assessment and hazard analysis)
- Verification and validation modelling language (VVML)
- VALU3S web-based repository (https://repo.valu3s.eu/)
- Standards and standardisation initiatives
- VALU3S demonstrations

In addition to the above topics, the participants will have the opportunity to present and disseminate their research in poster sessions.

The summer school is planned to take place in Genova, Italy on 18th-20th July 2023 with the support of the partners within the Italian cluster. The estimated cost for registration (per participant) is around 180€.

If you are a student (bachelor, master, or Ph.D.) or an early-stage researcher/engineer with an interest in expanding your knowledge around verification and validation, we recommend you to join us!

Register here >

Figure 3.1. Announcement of VALU3S summer school in latest edition of the project's newsletter.

VALU3S is organizing a summer school!

The VALU3S project is proud to organize a summer school with the focus on the results produced during the project. The theme of the school is ***Verification and Validation of Dependable Cyber-Physical Systems,*** and the tentative schedule of the summer school is as follows:

	Tuesday - 18th	Wednesday - 19th	Thursday - 20th
9h00 - 10h30	Introduction to verification and validation of dependable cyber-physical systems	VVML: Specifying Workflows for V&V Methods	Symbolic Model Checking of Hybrid Systems
10h30 - 11h00	break	break	break
11h00 - 12h30	An overview to *Testing* of safety-critical cyber-physical systems	Formal Requirements Engineering	Deductive Verification in a Nutshell
12h30 - 14h00	lunch & Poster presentations	lunch & Poster presentations	lunch & Poster presentations
14h00 - 15h30	Software-implemented fault injection	Introduction to Model Checking	An overview of relevant safety and cybersecurity standards
15h30 - 16h00	break	break	break
16h00 - 17h30	Simulation-based fault injection	A V&V framework for storing elements of V&V activities	An overview of relevant safety and cybersecurity standards

The summer school is planned to take place in **Genova, Italy** on **18th-20th July 2023** with the support of the partners within the Italian cluster. The estimated cost for registration (per participant) is around 180€.

If you are a student (bachelor, master, or Ph.D.) or an early-stage researcher/engineer with an interest in expanding your knowledge around verification and validation, we recommend you to join us!

Figure 3.2. Summer school webpage in VALU3S website.

Chapter 4 Conclusions

In this document we report on the dissemination and training results obtained during the project's lifetime, according to the KPIs that have been defined for the project. From the information provided, the reader can conclude that all objectives have been successfully achieved. Hence, we provide in the tables below the defined KPIs and the achieved values.

Table 4.1. Dissemination KPIs - proposed vs. achieved values.

.PI	Description	Proposed Value	Achieved Value
Diss-KPI-1	Total number of publications	≥ 90	**90**
Diss-KPI-2	Total number of workshops organized or sponsored by VALU3S	≥ 3	**8**
Diss-KPI-3	Total Number of VALU3S results made available as open-source projects	≥ 15	**16**

In the table above it is clear that all three dissemination KPIs have been successfully realized. We note that for both Diss-KPI-1 and Diss-KPI-3 we expect to increase the reached values, as there are still several publications being evaluated by the committees of the target venues, and open-source projects are still being finalized, respectively.

Table 4.2. Training KPIs - proposed vs achieved values.

KPI	Description	Proposed Value	Achieved Value
Train-KPI-1	Total number of training materials developed by the project	≥ 25	**87**
Train-KPI-2	Total number of internal training sessions	≥ 6	**18**
Train-KPI-3	Total number of training sessions open to external audience	≥ 1	**13**
Train-KPI-4	Organization of summer or winter schools	≥ 1	**1**

Like in the case of the dissemination KPIs, all training KPIs were also successfully achieved. However, and contrary to the dissemination KPIs, the values presented in the table above are the final ones. The 87 training materials refer to the sum of the training materials embedded in the open-source repositories, which amount to 16, and 71 videos (including the training sessions and the short videos on use cases and tools). We note that regarding Train-KPI-3, the value achieved, 13, includes a training organized in an external summer school, while the remaining 12 refer to the individual classes to be given during the summer school organized by VALU3S.

References

[1] International Organization for Standardization. ISO/SAE 21434:2021 Road vehicles — Cybersecurity engineering. Retrieved from https://www.iso.org/standard/70918.html

[2] International Organization for Standardization. ISO 26262-1:2011 Road vehicles — Functional safety. Retrieved from https://www.iso.org/standard/68383.html

[3] International Organization for Standardization. ISO/PAS 21448:2019 Road vehicles — Safety of the intended functionality. Retrieved from https://www.iso.org/standard/70939.html

[4] ISEP. 2021. Deliverable D6.12 - Final Dissemination and Training Plan.

[5] ISEP and et al. 2020. Deliverable D6.3 - Initial Dissemination and Training Plan.

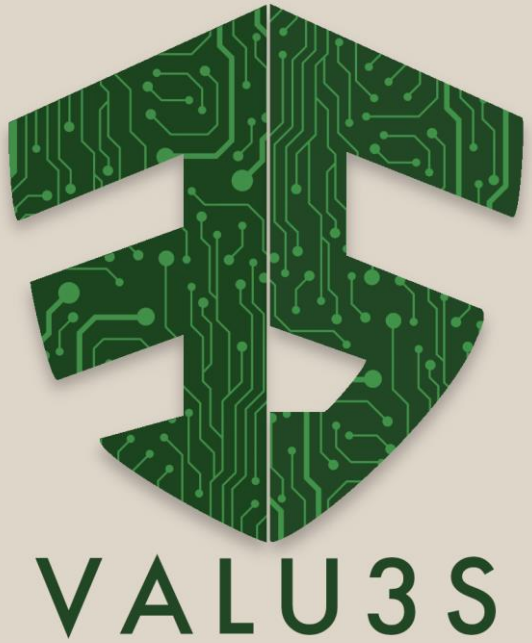
[6] RISE Research Institutes of Sweden. 2020. VALU3S: Verification and Validation of Automated System's Safety and Security. *VALU3S: Verification and Validation of Automated System's Safety and Security*. https://valu3s.eu

[7] UCLM, AIT, et al. 2020. Deliverable D3.1 - V&V methods for SCP evaluation of automated systems.

[8] VALU3S Consortium. VALU3S LinkedIn Page. https://www.linkedin.com/company/valu3s-project/

[9] VALU3S Consortium. VALU3S Twitter Page. https://twitter.com/valu3s_project

[10] VALU3S Consortium. VALU3S YouTube Channel. https://www.youtube.com/channel/UCBvhaW8hkWgopiJWbFBrIFQ



www.valu3s.eu

ECSEL Joint Undertaking
Electronic Components and Systems for European Leadership

This project has received funding from the ECSEL Joint Undertaking (JU) under grant agreement No 876852. The JU receives support from the European Union's Horizon 2020 research and innovation programme and Austria, Czech Republic, Germany, Ireland, Italy, Portugal, Spain, Sweden, Turkey.