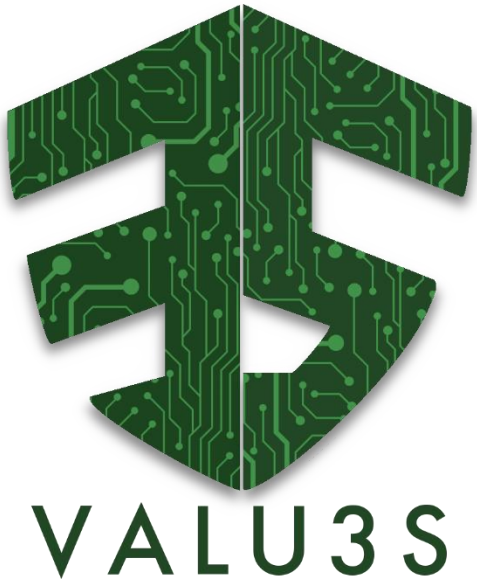

Verification and Validation of Automated Systems' Safety and Security

Interim Dissemination and Training Activity Report

Document Type	Report
Document Number	D6.15
Primary Author(s)	ISEP
Document Date	2022-04-28
Document Version	1.0 Final
Dissemination Level	Public (PU)
Reference DoA	2021-10-14
Project Coordinator	Behrooz Sangchoolie, behrooz.sangchoolie@ri.se, RISE Research Institutes of Sweden
Project Homepage	www.valu3s.eu
JU Grant Agreement	876852

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.

Disclaimer

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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 standardization 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

This deliverable reports all activities related to dissemination and training that took place during the second year of the project. All the reported activities are framed within the final plans for dissemination and training established in month 18 of the project in D6.12 – *"Final Dissemination and Training Plan"* [1], which in turn are an update of D6.3 – *"Initial Dissemination and Training Plan"* [2]. Henceforth, the updates with respect to the initial plans established in that deliverable are recalled at the start of the current document and the various established dissemination and training Key Performance Indicators (KPI) are analysed and a global status of the project regarding these KPIs is presented.

Contributors

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Ali Sedaghatbaf	RISE	19.04.2022
Behrooz Sangchoolie	RISE	27.04.2022, 28.04.2022

Revision History

Version	Date	Author (Affiliation)	Comment
0.1	2022-03-18	David Pereira (ISEP), Giann Nandi (ISEP)	Initial Version of the deliverable submitted for internal evaluation.
0.2	2022-04-14	David Pereira (ISEP), Giann Nandi (ISEP)	Version integrating comments from first round of internal review.
0.3	2022-04-26	David Pereira (ISEP), Giann Nandi (ISEP)	Version integrating comments from the second round of reviews.
0.4	2022-04-27	Behrooz Sangchoolie (RISE)	Review of the final draft, while making minor formatting changes and leaving additional comments to be addressed.
0.5	2022-04-27	David Pereira (ISEP)	Implementation of changes resulting from previous internal review.
1.0	2022-04-28	Behrooz Sangchoolie (RISE)	Final version of the report to be submitted.

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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 Revisiting the Final Set of KPIs

In this chapter, we provide a brief overview of 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 – *"Initial Dissemination and Training Plan"* [2]). A more detailed explanation of planning and establishing the final set of KPIs for VALU3S is provided in D6.12 – *"Final Dissemination and Training Plan"* [1].

1.1 Dissemination KPIs

Regarding dissemination, the set of final KPIs is presented in Table 1.1. 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 1.1. 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.

1.1.1 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 (this estimation is based on the number of publications achieved during the first year of the project), 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.

1.1.2 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.

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

This indicator is a refinement of the old KPI focusing on the contributions of the project to the open-source community (whose list is reported in Section 2 of this document). This refinement is concerned with the kind of material to account for, which was originally considered training materials and tutorials. However, for the rest of the project, artifacts such as these are now part of KPIs defined and dedicated solely to training activities. Hence, for this indicator, we will be considering only other materials that will be made open-source, notably software developments that will be performed during the project as the result of technical activities of the corresponding partners.

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 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 1.2.

Table 1.2. 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

1.2.1 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 shall 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 will also include videos that partners have prepared on their methods & tools (and possibly the improvements/combinations that they produce during the project). Also, it will include 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).

1.2.2 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 already 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 focus has been put mostly in training sessions 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).

1.2.3 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.

1.2.4 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.

1.3 Relation with previous deliverables

This deliverable reports on the dissemination and training activities performed during the second year of the project, and it is therefore tightly related to D6.12 – *"Final Dissemination and Training Plan"* [1], which in turn relates to the deliverable that proposed the first plan for dissemination and training, i.e, D6.3 – *"Initial Dissemination and Training Plan"* [2]. Moreover, this interim report is a continuation of the reporting made about the activities performed during the first year of the project, and that have been reported already in D6.7 – *"Initial Dissemination and Training Report"* [3].

Chapter 2 Dissemination Activities

In this section we report the activities that focused on dissemination, following along the various KPIs defined for the project.

2.1 Publications

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 list below presents the 31 publications achieved during the second year of the project. From the total of 31 publications, 12 were industrial publications, and 19 academic publications.

- 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.
  Industrial Publication: no.
- Farrell, M., Luckcuck, M., Sheridan, O., & Monahan, R. ***"Towards Refactoring FRETish Requirements,"*** in NASA Formal Methods Symposium, 2022. To appear.
  Industrial Publication: no.
- 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.
  Industrial Publication: no**.**
- 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
  Industrial Publication: yes.
- 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, doi: 10.1109/EDCC53658.2021.00014.
  Industrial Publication: no.
- 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, doi: 10.1109/DSN-S52858.2021.00036.
  Industrial Publication: no.
- 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. https://doi.org/10.1007/978-3-030-85347-1_24

Industrial Publication: yes.

- 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.
  Industrial Publication: yes.
- 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, doi: 10.1109/ISSRE52982.2021.00056.
  Industrial Publication: no.
- 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, doi: 10.1109/ACCESS.2021.3098644.
  Industrial Publication: no.
- 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), 2021, pp. 1-5, doi: 10.1109/PRDC53464.2021.00020.
  Industrial Publication: no.
- 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, pp. 1-11, doi: 10.1109/LADC53747.2021.9672584.
  Industrial Publication: no.
- 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. https://doi.org/10.1007/978-3-030-94238-0_1
  Industrial Publication: no.
- 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, doi:10.53525/jster.979689
  Industrial Publication: yes.
- 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)
  Industrial Publication: no.
- Santana, J., et al.,***"Evaluating the feasibility of a RISC-V core for real-time applications using a virtual prototype."*** DVCon-US 2022
  Industrial Publication: yes.
- 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)", Otomatik Kontrol Ulusal Kongresi – TOK 2021, 2 - 04 September 2021, pp.1-6

Industrial Publication: no.

- 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.
  Industrial Publication: yes.
- 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).
  Industrial Publication: no.
- 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.
  Industrial Publication: yes.
- 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, doi: 10.1109/QRS-C55045.2021.00034..
  Industrial Publication: yes.
- 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, doi: 10.1109/QRS-C55045.2021.00170.
  Industrial Publication: no.
- 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. doi:10.1002/rnc.6124.
  Industrial Publication: no.
- Agirre, J., et al., ***"The VALU3S ECSEL project: Verification and validation of automated systems safety and security, Microprocessors and Microsystems"***, Volume 87, 2021, 104349, https://doi.org/10.1016/j.micpro.2021.104349.
  Industrial Publication: yes.
- 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). https://doi.org/10.1007/s00170-021-08125-9.
  Industrial Publication: yes.
- Martínez, A., et al., ***"Facial Emotion Recognition from an Unmanned Flying Social Robot for Home Care of Dependent People."*** Electronics 2021, 10, 868. https://doi.org/10.3390/electronics100708689.
  Industrial Publication: yes.
- de la Vara, J., García, A., Valero, J., et al. ***"Model-based assurance evidence management for safety–critical systems"***. Softw Syst Model (2022). https://doi.org/10.1007/s10270-021-00957-z.
  Industrial Publication: no.

- 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..
  Industrial Publication: no.
- 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.
  Industrial Publication: no.
- 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.
  Industrial Publication: yes.
- 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
  Industrial Publication: no.

2.2 Organization and Sponsoring of Workshops

The second training KPI of VALU3S, Diss-KPI-2 – *"Total number of workshops organized or sponsored by VALU3S"* (see Section 1.1) focuses on the efforts of the project in contributing to the organization and/or sponsoring of workshops open to the community. The objective is to be involved in, at least, 3 workshops along the lifetime of the project. During the second year, members of the VALU3S consortium have been involved in the following activities regarding organization and/or sponsoring of workshops:

- ***CPS Segment @ HiPEAC 2022:*** 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 STEADINESS workshop will take place in Budapest, on the 22nd June, 2022. Moreover, VALU3S members are also chairing the communication committee of the overall segment.
  Workshop web site: https://www.hipeac.net/2022/budapest/#/program/sessions/7939/
- ***FMAS 2021: Third Workshop on Formal Methods for Autonomous Systems:*** this workshop which took place on the 21st and 22nd of October, 2021, was organized by VALU3S partner NUIM. The previous edition of this workshop has also been organized in the scope of VALU3S, and NIUM partners are already working on organizing the 2022 editon (which is expected to take place already during the 3rd year of the project).
  Worshop web site: https://fmasworkshop.github.io/FMAS2021/
- ***"Verification and validation methods for Robotic Systems"*** (collocated with the Turkish Robotics Confoerence, ToRK 2021 - 26-28 July 2021, which was organized by VALU3S partners ESOGU. The event took place online.
  Conference Web Site: https://tork2021.iyte.edu.tr/en/home-page/
  Workshop Program: https://ifarlab.ogu.edu.tr/Haber/Detay/17/robotic-workshop-in-tork-2021

Workshop Video: https://www.youtube.com/watch?v=tM1NSUvrazM

Considering the workshops already organized during the 1st year of the project, and the ones presented above, the project has already achieved the target established by Diss-KPI-2. Nevertheless, the consortium will continue with the effort of identifying more opportunities for VALU3S to get involved in the organization and/or sponsoring of workshops since these are privileged dissemination channels to convey results to external audiences.

2.3 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 1.1) whose target is to achieve 15 open-source projects until the end of the project. The currently available open-source results are presented in Table 2.1 to Table 2.11.

Table 2.1. 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 2.2. 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 2.3. 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 2.4. 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 2.5. 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	Apache2.0
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 2.6. 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 2.7. 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/shecan do it on Gazebo.					

Table 2.8. 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 2.9. 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 2.10. 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 2.11. 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.					

Currently, there are already 11 open-source developments available to the external communities, meaning that the project is missing 4 new open-source projects to reach its objective. Given that there is still several technical work being performed in aspects such as improvement and combination of V&V methods (and associated tools), the project foresees to achieve the intended number during the last year of the project.

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. Training is a continuous activity that has been implemented early in VALU3S and has been very well received so far by the whole consortium, and therefore such training efforts will remain as a key activity during the remaining lifetime of the project.

3.1 Training Materials Developed

During the second year of the project, most materials (as in the case of the first year) have assumed the form of videos of differente kinds.

3.2 Internal Training

Since the first year, VALU3S has put efforts in planning and implementing a track of internal training sessions. The goal of this training is to increase the awareness of consortium members regarding methods and tools being addressed in the project, and also to support standardisation in the sense of providing information about standards that are relevant to the activities of the project. In fact, during the second year of the project, the majority of efforts have been directed toward feeding the stream of internal training events with topics related to standards that have been identified or recommended as important to the scope and objectives of the project.

All training sessions are recorded and afterwards made available in the project's website [4], in the project's YouTube profile [5] and are periodically announced on the social networks [6][7]. The total number of views of all training sessions reaches already the 1348, with 1335 referring to videos produced and published during the first year of the project, and 13 relative to those that took place during the second year (which have been published roughly one week before the time of finalizing the current document, and which have not yet been announced in the project's social networks).

The list of training sessions that took place during the second year of VALU3S is presented in Table 3.1. With these sessions, the project has reached a total number of 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 already been successfully achieved. Despite this fact, the consortium will continue to maintain efforts on implementing the internal training initiative alive and plans to have a similar number of training sessions during the last year of the project.

Table 3.1. List of training sessions that took place during the second year of VALU3S.

VALU3S Partner	Speaker(s)	Title of the Training	Date
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	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
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

VALU3S Partner	Speaker(s)	Title of the Training	Date
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 Link: 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	April, 14, 2022

3.2.1 Training Satisfaction Questionnaire

To evaluate the satisfaction of the project partners regarding the training sessions focused on standardization, a satisfaction questionnaire was produced and sent to all members of 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. At the end of the questionnaire, partners have the possibility to leave comments and suggestions in the form of an open question. Figure 3.1 shows a screenshot taken from the survey and serves to illustrate the adopted format.

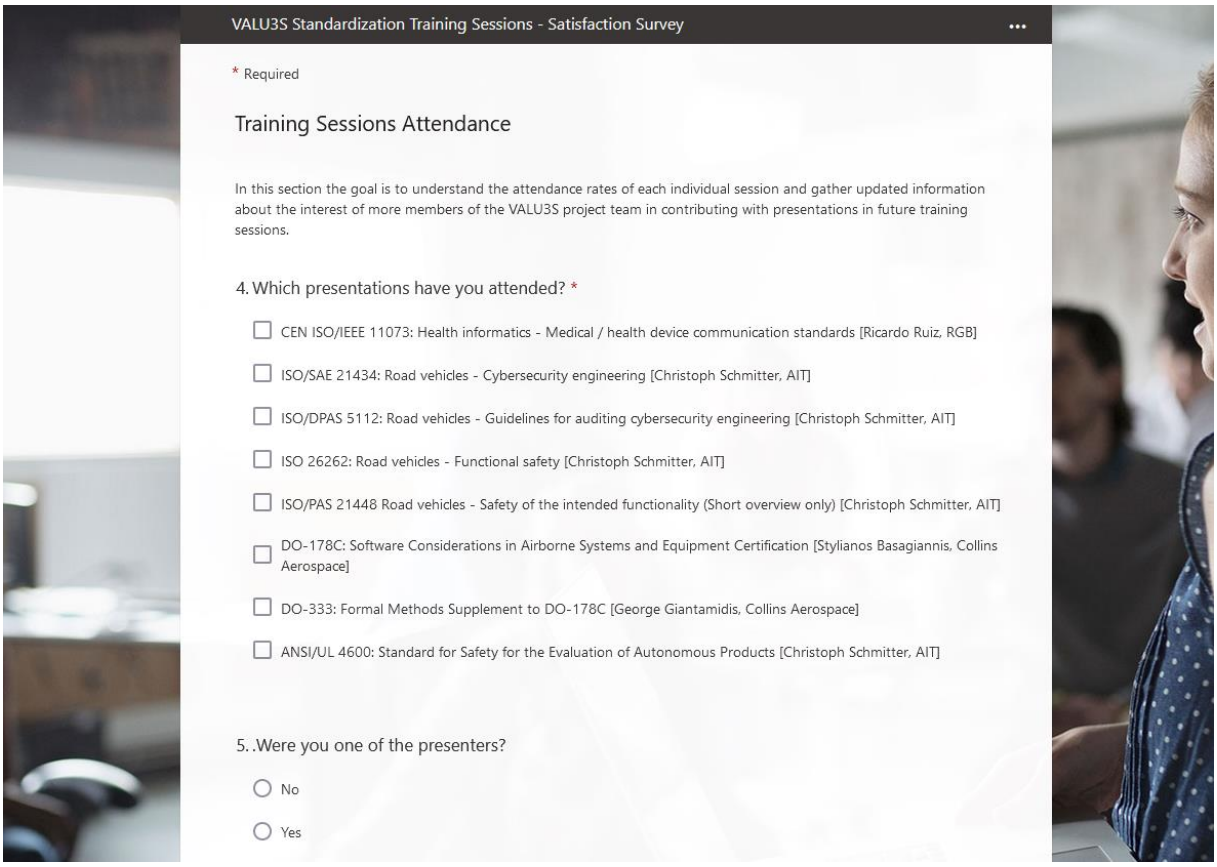

Figure 3.1. Example page of the satisfaction questionnaire.

The first section of the questionnaire is simply concerned with the identification of the project partner. The questions are presented in Table 3.2.

Table 3.2. Questions of the survey regarding the participant identification (Q1-Q3).

Question Nº	Question
1	Please provide your first and last names.
2	Please provide your email.
3	Please indicate the shortname of your organization.

The second section of the survey aimed to identify the training sessions with the most attendees among the survey repliers and check how many of these participants would be willing to contribute to future training sessions as a presenter. Those who showed interest in leading training sessions were also asked to provide a topic for the session. Table 3.3 presents the questions and the available answer options in the case of the multiple choice questions included in the second section of the survey.

Table 3.3. Questions of the survey regarding attendance in the training sessions (Q4-Q7).

Question Nº	Question
4	Which presentations have you attended?
Options	• CEN ISO/IEEE 11073: Health informatics - Medical / health device communication standards [Ricardo Ruiz, RGB] • ISO/SAE 21434: Road vehicles - Cybersecurity engineering [Christoph Schmittner, AIT] • ISO/DPAS 5112: Road vehicles - Guidelines for auditing cybersecurity engineering [Christoph Schmittner, AIT] • ISO 26262: Road vehicles - Functional safety [Christoph Schmittner, AIT] • ISO/PAS 21448 Road vehicles - Safety of the intended functionality (Short overview only) [Christoph Schmittner, AIT] • DO-178C: Software Considerations in Airborne Systems and Equipment Certification [Stylianos Basagiannis, Collins Aerospace] • DO-333: Formal Methods Supplement to DO-178C [George Giantamidis, Collins Aerospace] • ANSI/UL 4600: Standard for Safety for the Evaluation of Autonomous Products [Christoph Schmittner, AIT]
5	Were you one of the presenters?
Options	• No • Yes
6	Would you be interested in, or available for contributing with a training session in the future?
Options	• Yes • No • Maybe
7	Since you replied "Yes" or "Maybe" in the previous question, what would be the topic that you would be willing to present in a future training session?

The third and last section of the survey covered the attendees' satisfaction with the training sessions. Partners were asked to choose the training sessions that were the most relevant to them and provide a justification for their choices. In case the listed options did not fit the partner's motivation, the survey provided a section for them to elaborate on their choices.

Partners were then asked to share their views regarding the amount of content presented at the training sessions. In the cases where the partner was already familiar with the standard, we asked if they managed to learn something new from the presentation.

To determine if clarifying standards and identifying those working with them triggered any collaborations, we asked partners if these training sessions motivated them to contact partners and initiate talks about partnerships. To finalize the questionnare, partners were asked to provide a rating from zero (not satisfied at all) to five (better than expected) regarding their overall satisfaction with the training sessions.

Table 3.4. Questions of the survey regarding the attendants' satisfaction with the training sessions (Q8-Q14).

Question Nº	Question
8	Which sessions were more relevant for you?
Options	• CEN ISO/IEEE 11073: Health informatics - Medical / health device communication standards [Ricardo Ruiz, RGB] • ISO/SAE 21434: Road vehicles - Cybersecurity engineering [Christoph Schmittner, AIT] • ISO/DPAS 5112: Road vehicles - Guidelines for auditing cybersecurity engineering [Christoph Schmittner, AIT] • ISO 26262: Road vehicles - Functional safety [Christoph Schmittner, AIT] • ISO/PAS 21448 Road vehicles - Safety of the intended functionality (Short overview only) [Christoph Schmittner, AIT] • DO-178C: Software Considerations in Airborne Systems and Equipment Certification [Stylianos Basagiannis, Collins Aerospace] • DO-333: Formal Methods Supplement to DO-178C [George Giantamidis, Collins Aerospace] • ANSI/UL 4600: Standard for Safety for the Evaluation of Autonomous Products [Christoph Schmittner, AIT]
9	Why did you choose this/these presentation(s) as more relevant?
Options	• The standard was directly linked to a use case where I am involved. • It was a standard that I was already interested in, but never got the chance to dive further into it. • I did not know about it, but it provided a new perspective for my activities. • None of the above reasons.
10	Please provide a brief justification for your choice of the most relevant presentations.
11	Overall, do you feel like the presentations provided enough information for those not familiar with the standards?
Options	• Yes, I think enough information has been provided. • No, I feel like presentations were too vague. More details should have been presented. • Yes, but presenters could've gone into further details.

Question Nº	Question
12	Did you learn something new from the presentations of standards that you were already familiar with?
Options	• Yes • No • I wasn't familiar with any of the standards.
13	Did these training sessions contributed in some way to possible new collaborations?
Options	• I identified partners for possible future collaborations. • I identified partners and already initiated contact with them. • No
14	From 0 (not satisfied at all) to 5 (better than expected), how do you classify your overall experience as participant of all the training sessions that took place so far?
Options	• - • ★ • ★★ • ★★★ • ★★★★ • ★★★★★

3.2.2 Survey Results

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 [8] and ISO 26262 [9] 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 [10] 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 questionnare, 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" were given and will be taken into consideration when planning for future training sessions during the last year of the project.

3.3 External Training

Regarding training directed towards external audiences, during the second year VALU3S got involved in the organization of a module for the SSonCPSIoT'2022 - 3rd Summer School on Cyber Physical System and Internet of Things [11], entitled *"How to design and tailer a perfect fitting verification and validation process for your CPS&IoT project"*, and whose preparation involves the participation of several partners of the project. The structure of the training module, which will have a total duration of 90 minutes, is the following:

- Motivation (5m)
- Project Overview and Objectives (10m)
- Project Structure and Assets (5m)
- Use case and demonstrators (10m)
- V&V Framework (10m)
- V&V Methods (10m)
- V&V Tools+Workflows (15m)
- Standardization (10m)
- Closing (5m)
- Questions (10m)

In each of the above defined parts of the session, contents produced within VALU3S will be introduced to the audience. It is expected that, by the end of the session, attendeeds will have a comprehensive understanding of the work being performed in the project and, consequently, contribute to the research/work lines that these attendees are pursuing. Moreover, it is expected that these attendees will act as vectors of conveying the contents of VALU3S to their communities and thus contribute to an increased understanding of the importance of the project's results to those stakeholders addressing the topic of V&V of SCP properties for autonomous systems.

With the organization of this workshop, VALU3S achieves the corresponding KPI, that is, Train-KPI-3, which was defined to consider at least one workshop organized for external audiences (see Section 1.2).

Nevertheless, VALU3S partners will continue to monitor future opportunities to contribute with the organization of more workshops targeting external audiences until the end of the project.

Chapter 4 Conclusions

In this chapter we present the conclusions regarding the performance of the project in what concerns both dissemination and training activities. The conclusions presented are the result of comparing the target values established for each of the defined KPIs with respect to the values achieved so far.

4.1 Dissemination Activities

In what concerns dissemination activities, and considering the KPIs defined for the whole duration of the project when compared to the current values achieved so far, as presented in Table 4.1, we can conclude that the project is performing well.

In what concerns publications, whose objective to reach is established by Diss-KPI-1 – *"Total number of publications"*, the project requires at least 90 publications to achieve the established objective. Currently the project has reached 55 publications in the first two years (24 in the first year and 31 in the second year). There was an increase in the number of publications during the second year and we believe that this is an indicator, (together with the large body of work planned and being performed by the partners up to the end of the project), the VALU3S will achieve the objective established by Diss-KPI-1.

Regarding Diss-KPI-2 – *"Total number of workshops organized or sponsored by VALU3S"*, which is focused on the organization and sponsoring of workshops (whose audiences are external to the project), the defined goal has already been achieved during the second year of the project. VALU3S aimed at organizing and/or sponsoring at least 3 workshops but it has already done so for 4 workshops. The total number is expected to increase in the last year of the project.

In the case of Diss-KPI-3 – *"Total Number of VALU3S results made available as open-source projects"*, the project is close to achieve the target goal. The aim is to contribute with at least 15 open-source project's and 11 are already available. Following the same reasoning used for the case of Diss-KPI-1, i.e., many partners are still developing planned tools and building demonstrators, it is expected that more open-source projects will arise from those efforts and we believe that the goal of having at least 15 open-source projects made available by the end of the project, will be achieved in the last year.

Table 4.1. Dissemination KPIs - target KPI values vs. current achievements.

KPI	Description	Target Value	Current Value
Diss-KPI-1	Total number of publications	≥ 90	55
Diss-KPI-2	Total number of workshops organized or sponsored by VALU3S	≥ 3	4
Diss-KPI-3	Total Number of VALU3S results made available as open-source projects	≥ 15	11

4.2 Training Activities

Regarding the training activities, during the second year the project consortium has been very active and the results obtained are considered to be very satisfying, with most of the training KPIs being already achieved (see Table 4.2).

In what concerns Train-KPI-1 – *"Total number of training materials developed by the project"*, during the second year the project has produced 59 videos, resulting from training sessions, use case overviews, and short videos on V&V methods and tools, which are available both for internal training and for external audiences. We can thus conclude that VALU3S reached the proposed objective of producing at least 25 of such materials. Moreover, with the work still being performed in the project, it is expected that the number of training materials will increase during the last year of the project.

In the case of training sessions, Train-KPI-2 – *"Total number of internal training sessions"* proposes that the project organizes at least 6 throughout its duration. Just during the second year that goal was achieved, and summing to those organized during the first year, the project reached a total of 10 training sessions, where 2 have been organized during the first year and 8 during the second year.

Regarding Train-KPI-3, the project is involved in the SSonCPSIoT'2022 summer school and is contributing with a training module. Hence VALU3S has reached the minimum value established by the KPI. The consortium will continue to monitor for opportunities to get involved in similar events during the last year of the project.

Finally, when it comes to Train-KPI-4 – "Organization of summer or winter schools", the project has not yet reached the objective of having organized a summer/winter school. Nevertheless, the plan is to organize such an even during the last year of the project and planning is already progressing. Hence, it is expected that more concrete actions regarding the organizational aspects of the envisioned summer school start being put in place during the next months of the project. Nevertheless, and as already mentioned, the project has put efforts on contributing to one of the more relevant summer schools in the area of CPS and the Internet of Things. Despite not being part of the organization, the participation on that summer school will serve as an important instrument for the organization of the foreseen summer/winter school to be organized by VALU3S during its last year.

Table 4.2. Training KPIs - target KPI values vs. current achievements.

KPI	Description	Target Value	Current Value
Train-KPI-1	Total number of training materials developed by the project	≥ 25	59
Train-KPI-2	Total number of internal training sessions	≥ 6	10
Train-KPI-3	Total number of training sessions open to external audience	≥ 1	1
Train-KPI-4	Organization of summer or winter schools	≥ 1	0

4.3 Dissemination and Training as a Whole

Given the results presented in the above two subsections, we can see that VALU3S is performing according to what has been defined in the final plan for dissemination and training. Although some of the KPIs have not yet been achieved, which is natural since the project has one year up ahead, the evolution of the outcomes clearly indicates that the project is on the right path towards successfully meeting all the goals set up by the dissemination and training KPIs. In this last year, special attention and efforts will be put in the planning and organization of Train-KPI-4 to ensure that a summer/winter schools is successfully organized, while efforts on monitoring and motivating partners on participating in the several dissemination and training activities are maintained, and increased whenever possible (e.g., on sponsoring/organizing workshops and tutorial sessions to external audiences in order to increase the visibility and relevance of VALU3S results to practitioners of V&V of SCP for autonomous systems).

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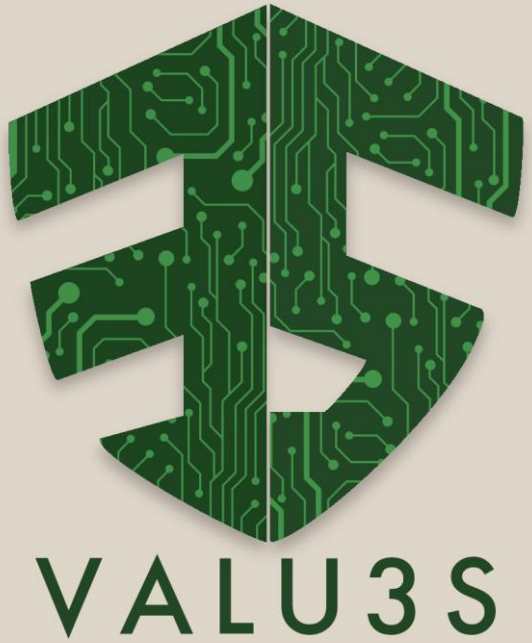

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ECSEL Joint Undertaking
Electronic Components and Systems for European Leadership

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.