Dissemination Plan and Report

[WP5; T5.3; Deliverable: D5.3 version 1.3]

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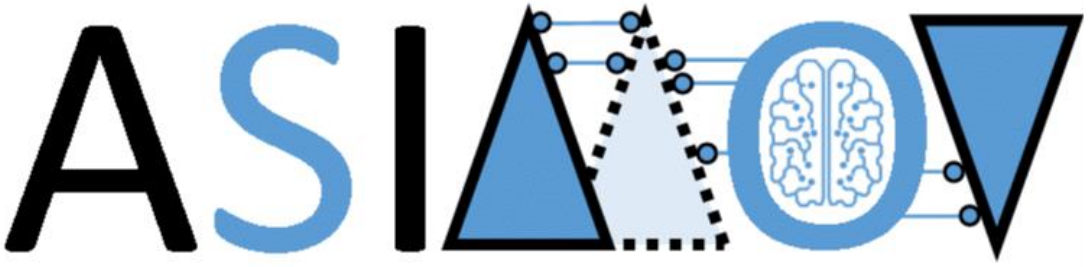

AI training using Simulated Instruments for Machine Optimization and Verification

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Version	Date	Reviewer
1.0	2022.02.10	Tabea Henning (DLR); Niklas Braun (AVL)
1.1	2022.08.19	Jan van Doremalen (CQM); Hans Vanrompay (TFS)

Change History

Version	Date	Reason for Change

1.0	2022.02.10	First version, based on the plans and reports of the Dutch and German partners, with some contributions from Finnish partners (pending the funding decision in Finland)
1.1	2022.06.22	M12 update to results and consortium (removal of Finland)
1.2	2023.07.25	M24 updates
1.3	2024-05-10	M36 updates from all consortium members

Abstract

The ASIMOV-project develops technologies to combine Digital Twinning and Machine-Learning (e.g., Reinforcement Learning) to automate the calibration, optimization of Cyber Physical Systems. The project is centred around industry use cases to ensure that the technology developed in the project will meet actual industry needs. To enhance the value of the ASIMOV-project, initiatives will be taken to disseminate these.

This document provides an overview of the dissemination plans of the ASIMOV-consortium as well as report on the actual results.

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1 Introduction

High-tech cyber-physical systems (CPSs) play increasingly important roles in our society. They are ubiquitous, and companies, organizations and societies depend on their correct functioning. CPSs need to have high up-times, be user-friendly, and economically to use. CPS suppliers must assure that their systems reliably deliver optimal quality in customers' environments, without bothering their customers with complex system optimisation tasks that require highly skilled staff. Systems need to be optimally tuned before delivery and at installation and re-adjusted during use. Such optimization can easily require many hours/days and this total time increases rapidly due to growing project diversity and complexity. To address this major problem, it is ASIMOV's vision that CPSs must be increasingly autonomous and self-optimising, which leads to the following central question:

How to build complex high-tech systems that select their optimal settings autonomously within minimal time and with minimal external expertise?

To answer this question, the ASIMOV project will develop innovative technologies to create self-optimising CPSs by combining AI and Digital Twinning. The consortium, consisting of large industrial parties, SME's with strong AI-expertise, and leading universities and research institutes, will deliver the following innovations:

- creating digital twins of systems to simulate realistic system behaviour;
- training an Optimisation-AI based on the digital twin to find optimal system settings;
- verifying the validity of the digital twin for training the AI;
- using the trained AI to perform the tuning and calibration tasks on actual machine configurations.

This will lead to AI-based software that autonomously performs system optimisation tasks during manufacturing, installation, and system usage. Proof of concepts will be provided in two different industrial system domains (electron microscopes and automated driving) for which optimisation is crucial for system performance.

The key objectives of the dissemination are to create public awareness of the ASIMOV methods, tools and results, showing the industrial feasibility and applicability, knowledge sharing and exchange and actively transfer ASIMOV results to specific industrial and academic target groups. All project partners, especially the applied research partners, will present findings at international conferences and workshops, feed insights into special interest groups, as well as publish research results in peer-reviewed journals and conference proceedings. Industrial partners will complement dissemination of results through the realization of proof-of-concepts, field tests and in-product-demonstrations showcasing achievements at professional exhibitions. Public dissemination: promote and support (white) papers, articles, conference contributions, innovation markets, invited talks, industrial exhibitions, etc. Use widely available platforms to make the public reports and papers available, e.g., a public ASIMOV website, an ASIMOV page on Wikipedia, an ASIMOV project entry on ResearchGate, an ASIMOV page on LinkedIn etc.

This document gives an overview of the plans to disseminate the ASIMOV results to create awareness by creating industrial and social added value. In addition to the plan, the document also provides a report of the current exploitation status.

2 Consortium Overview

Company Name (Project coordinator first)	**Country**	**Role *)**	**Type of organisation **)**				
			I	**S**	**U**	**R**	**O**
FEI Electron BV (TFS)	The Netherlands	C	x				
Netherlands organization for applied scientific research (TNO)	The Netherlands	M				x	
Eindhoven University of Technology (TUE)	The Netherlands	P			x		
CQM B.V. (CQM)	The Netherlands	P		x			
OFFIS e. V. (OFFIS) **until December 31, 21**	Germany	M				x	
Deutsches Zentrum für Luft- und Raumfahrt (DLR) **per January 1, 2022**	Germany	M				x	
AVL Deutschland GmbH (AVL)	Germany	P	x				
NorCom Information Technology GmbH & Co. KGaA (NORCOM)	Germany	P		x			
LiangDao GmbH (LIANGDAO)	Germany	P		x			
RA Consulting GmbH (RAC)	Germany	P		x			
TrianGraphics GmbH (TG)	Germany	P		x			

Table 1 - Consortium Overview

*) C = Coordinator; M = country's Main participant contact; P = Participant
**) Type of organisation: I=Industry; S=SME; U=University, R=Research Institutes, O=Other

NOTE:
The German consortium has changed since submission of the FPP. The table above reflects the current composition of the consortium, i.e. OFFIS is converted to DLR. A CR will be submitted to ITEA to reflect the change. It is in progress for submission in September 2022.

NOTE:
All Finland participation is removed in version 1.1. of this document and their withdrawal from the consortium will be reflected in the CR.

3 Dissemination Plan

3.1 Industrial Partners

Dissemination Description	Planned date
AVL	
Presentation of the project in social media channels of AVL	M8
Presentation of project content and intermediate results in internal workshops at AVL	M12, M24
Presentation of final results in internal workshops at AVL	M36
Presentation of project results at international conferences, e.g., Symposium on Development Methodology in 11/2024	M30 - M36
Symposium presentation: Schyr, C.; Braun, N.; Oberpeilsteiner, S.: *AI-based Optimization of Digital Twins of Unmanned Commercial Vehicles*. 7th International Commercial Vehicle Technology Symposium (Kaiserslautern, September 2022)	M15
Schyr, C.; Braun, N.; Hartwecker, A.; Müller, S.; Oberpeilsteiner, S.: *Efficient Use of Multibody Simulation on the Vehicle-in-the-Loop Test Bench.* AVEC 2022 (Kanagawa, Japan 2022)	M15
CQM	
Transfer knowledge within customer projects from CQM to customer	ongoing
Transfer knowledge to our (potential) customer base and market by means of blogs, workshops, white papers, seminars.	ongoing
Publish at least 3 whitepapers on ASIMOV topics on CQM website	2023
LIANGDAO	
Presentation of LiangDao's contribution at ASIMOV and results at conferences	From 2023 on
Presentation of project content and intermediate results in internal workshops at LiangDao	From M15 on
Roadshow at customer in case of requirements regarding lidar simulation	From 2023 on
NORCOM	
Presentation of the ASIMOV project to customers	M8 - M36
Presentation of project intermediate results in internal workshops	M8 - M36
RAC	
Yearly multiple roadshows at customer sites	from 2023 on
Once per year presentation on the RA User Day	from 2023 on
Yearly multiple conference and show participations	from 2023 on
Continuously evaluation of possible standardisation activities	from 2023 on
TFS	
Presentation of the ASIMOV project and technical results during Thermo Fisher Scientific Technology Conferences	M36
1-2 publications at International Conferences and in peer-reviewed Journals	M18-M36
Monthly dissemination to BU stakeholders	from 2023 on
TG	
Presentation of results as papers and presentations at international conferences (DSC,….)	M24
Announcement of upcoming new features at exhibitions (I/ITSEC, DSC, Autosense,…)	M36
Social media marketing activities	M24

Table 2 - Dissemination Plans of Industrial Partners

3.2 Academic and Research Partners

Dissemination Description	Planned date
DLR	
1-2 academic publications + presentations on national conferences (e.g., DATE)	M8 – M36
5-6 academic publications + presentations on international conferences (e.g., SAFECOMP, CPS-WEEK)	M20 – M36
Participation and scientific-technical exchange on 2 (national/international) conferences like the BMBF/BMWK conference "Research and technology for automated and connected driving" and "International Workshop on Digital Twin Architecture" (TwinArch) co-located with European Conference on Software Architecture (ECSA)	M16 – M36

Dissemination Description	Planned date
Introduction of ASIMOV results w.r.t. AI application, resulting challenges and needs w.r.t. standardization into the amendment of the DIN standardization roadmap AI "Künstliche Intelligenz" within the focal topic "Mobility", in particular safe automated mobility; the goal of the roadmap is to describe the status quo and to develop recommendations for activities for politics, science, industry, and standardization bodies.	M10-M36
Presentation of ASIMOV on the networking conference “Future through transformation - impulses from and for the automotive industry" for disseminating transformation projects results to the automotive industry and other stakeholders in Lower Saxony and beyond.	M25
TNO	
Article about ASIMOV in ESI – 20 years book	M17
ASIMOV demonstration at ESI Symposium 2022 – 27th September 2022	M17
Bits&Chips Event (12-10-2023) presentation (https://bits-chips.nl/bitschips-event/)	M29
ASIMOV presentation at ESI Symposium 2024 – April 2024	M35
2 or 3 publications (conferences, journals, TNO reports etc.)	M24 – M36
ESI symposium- 2 presentations	M30-M36
ITEA PO Days, poster exhibition, in Antwerp	10 Sep 2024
TUE	
2-3 academic publications of the PhD students Jilles van Hulst and Roy van Zuijlen in leading control and CPS conferences such as ECC, ACC, IFAC World Congress, CPS week, IEEE CCTA and smaller dedicated workshops	M18 – M36
Journal publication in leading journals such as IEEE Transactions on Control Systems Technology, IFAC Control Engineering Practice, etc. (due to duration of review process for journals, several journal publications are expected after M36)	M25
2 PhD theses on ASIMOV research perspective	> M36

Table 3 - Dissemination Plans of Academic and Research Partners

3.3 Joint Dissemination Plans

Partners	Dissemination Description	Planned date
TFS, TNO, CQM, TUE	Industry reference group: workshops with 6 (at this moment) industries outside the ASIMOV-consortium to align on potential industry value and to share ASIMOV results. [Canon Production Printing, Lely, Philips, Smart Robotics, Ultimaker, Thales]	M12, M24, M30, M36
All	ASIMOV **public website** – www.ASIMOV-project.eu (action: AVL)	M6 shifted to M9
All	ASIMOV **Wikipedia** Page (action: TNO) Draft ASIMOV Wikipedia page submitted for review by Wikipedia) https://en.Wikipedia.org/wiki/Draft:ITEA4_ASIMOV_Project Publish future links to public ASIMOV papers and reports on this page.	M9
All	ASIMOV LinkedIn Page	M9
DLR, AVL, TFS, TNO, TrianGraphics	Article “Architecture for DT-based RL Optimization of Cyber-Physical Systems” (led by DLR, written by DLR and Working Group members) submission to 1st International Workshop on Digital Twin Architecture (TwinArch 2022) https://www.iese.fraunhofer.de/en/twinarch.html#1 co-located with the 16th European Conference on Software Architecture (ECSA) in Prague, Czech Republic	M14
TFS, TNO, CQM, TUE	Article about ASIMOV on Bits&Chips: https://bits-chips.nl/	M18
All	Publish public papers and reports via **ResearchGate**. Project has been created on ResearchGate: https://www.researchgate.net/project/ASIMOV-ITEA	M12
All	Publish public papers and reports via **LinkedIn**. Create a project on LinkedIn	M9
TNO. DLR	ESI symposium poster exhibition and demonstration	M34

Table 4 - Joint Dissemination Plans

Regarding the ASIMOV public website: hosting was delayed as a Finnish part volunteered to host (TietoEvry). AVL has volunteered and is able to host www.ASIMOV-project.eu.

Regarding the ASIMOV Wikipedia Page: a draft page is available and has been submitted to Wikipedia for review. The duration of the review process is unpredictable, but this is likely to take months.

Regarding the ASIMOV ResearchGate project, DLR has created a project after the withdrawal of Finland.

4 Dissemination Results

4.1 Industrial Partners

Dissemination Description	Date
AVL	
Paper accepted Schyr, C.; Braun, N.; Oberpeilsteiner, S.: *AI-based Optimization of Digital Twins of Unmanned Commercial Vehicles*. 7th International Commercial Vehicle Technology Symposium (Kaiserslautern, September 2022)	M11
Schyr, C.; Braun, N.; Hartwecker, A.; Müller, S.; Oberpeilsteiner, S.: *Efficient Use of Multibody Simulation on the Vehicle-in-the-Loop Test Bench.* AVEC 2022 (Kanagawa, Japan 2022)	M11
N. Braun, *Using AI to improve Scenario-Based Testing.* ESI Symposium 2022 (Veldhoven, NL 2022)	M15
Oberpeilsteiner, S.; Hartwecker, A.; Müller, S.; Braun, N.; Schyr, C.: *Effizienter Einsatz von MKS am Vehicle-in-the-Loop Prüfstand*. AVL German Simulation Conference. (Regensburg 2022)	
CQM	
Workshop on digital twins, surrogate models, optimization at a Philips department	M21
AI talk on bridging AI and commercial applications at KIVI (Koninklijk Instituut Van Ingenieurs)	M20
Internship of TU/e master student, practical machine learning in logistics	M19
Internship and final thesis University of Leiden student, automatic workflow for digital models	M34
Causality in AI and ML applications: event with over 100 customers and other relations	M36
Talk on AI applications at the ENBIS conference	M36
Talk on DT and AI in optimizing warehouse operations at ESCF (European Supply Chain Forum) seminar	M36
Seminar on use of AI to predict degradation of train systems/components at SLF (Service Logistics Forum) seminar	M36
Presentation of project on real-time scheduling of subsidized taxi rides for elderly and disabled citizens at Franz Edelman Award of INFORMS conference	M36
LIANGDAO	
NORCOM	
Presentation of the Asimov project to international business client in the automotive sector	Oct-2021
RAC	
TFS	
Remco Schoenmakers was interviewed at the Dutch/German Artificial Intelligence Expert Day (organized by Ministry of Economic Affairs) (March 24, 2021). He discussed the proposal for the ASIMOV-project and the potential and challenges of the technology.	Mar-2021
Presentation of Remco Schoenmakers at the Machine Learning conference of Bits&Chips	M1
Interview of Brainport Eindhoven with Remco Schoenmakers about AI, referring to ASIMOV: https://brainporteindhoven.com/nl/ontdek/de-kracht-van-brainport/cases/ai-is-vak-apart-dat-nog-volwassen-moet-worden (in Dutch)	
Quarterly live demonstrations at the electron microscope for BU stakeholders	From 2023 onwards
TG	
Conference Presentation DSC 2023 Europe (Driving Simulation Conference), Antibes Digital Twin - Generation and Variation in Reinforcement Learning	September 2023
Conference Presentation Graz Symposium Virtual Vehicle 2023 Digital Twin - Generation and Variation in Reinforcement Learning	September 2023

Dissemination Description	Date
Conference Presentation Autonomous Vehicles Europe 2023, Berlin Validation of ASAM OpenX & Variation of 3D Scene Maps	November 2023

Table 5 - Dissemination Results of Industrial Partners

4.2 Academic and Research Partners

Dissemination Description	Date
DLR/OFFIS	
Article about ASIMOV in OFFIS in-house public magazine article "Datawork No. 73", available under https://www.offis.de/en/offis/downloads-and-tools/datawork-offis-journals.html)	M7
In the course of the amendment of the DIN standardization roadmap AI "Künstliche Intelligenz", results from ASIMOV with regard to AI application, the resulting challenges and needs with regard to standardization within the focal topic "Mobility", in particular safe automated mobility, have been introduced. The goal of the roadmap is to describe the status quo and to develop recommendations for activities for politics, science, industry, and standardization bodies.	M10-M12
Poster presentation of ASIMOV on the networking conference “Future through transformation - impulses from and for the automotive industry" for disseminating transformation projects results to the automotive industry and other stakeholders in Lower Saxony and beyond. (see https://automotive.nds.de/zukunft-durch-transformation/)	M25
Poster presentation of ASIMOV at Project exhibition during ITEA PO Days 2023 in Berlin, Germany.	M27
Presentation of position paper “Architecture for Digital Twin-based Reinforcement Learning Optimization of Cyber-Physical Systems” at TwinArch Workshop @ ECSA2023 in Istanbul, Turkey.	M27
Workshop paper “What to tell when? – Information Provision as a Game” published at Fifth Formal Methods for Autonomous System (FMAS)	M29
Presentation of the position paper “Architecture for Digital Twin-based Reinforcement Learning Optimization of Cyber-Physical Systems” at DLR institute internal seminar “SE Science Forum”.	M30
TNO	
Chapter on ASIMOV in TNO-ESI 20 years publication on Managing complexity of Cyber Physical systems. The publication can be downloaded here: https://publications.tno.nl/publication/34640058/iS48dL/roos-2022-managing.pdf pg 66	Sept 2022
Presentation at ESI Symposium titled "Learning in Digital Twins to automated the calibration of high-tech systems", NL 2022	M15
Two workshops in June and September 2023 with UltiMaker to discuss applicability of the ASIMOV solution on their use case. In the first workshop, TNO-ESI discussed about UltiMaker as a company, their system, customer base, and key challenges. Together with UltiMaker, TNO-ESI created a customer workflow including feedback loops to get a good overview of the business and challenges. In the second workshop, the focus was on ASIMOV, and mapping the UltiMaker use case onto the ASIMOV reference architecture. We presented and discussed four potential locations to apply the ASIMOV results. With the two workshops TNO-ESI created the following impact: • TNO-ESI explored an additional use case where the ASIMOV solution is applicable. • TNO-ESI suggested a new technical option for intermediate (possibly AI-based) calibration procedures during printing. These ideas may result in a patent, or company secret. • TNO-ESI helped UltiMaker with getting the potential value of an ASIMOV solution clear, using the mapping onto the reference architecture and by creating a workflow model of their customer printing flow. • TNO-ESI identified follow-up actions to further help UltiMaker improve their customer workflow by leveraging the network and training facilities available at TNO-ESI.	June, Sept 2023
Bits and Chips event	Oct 2023
Workshop with Philips IGT- TNO-ESI	8 Nov 2023
ASIMOV demonstrator in Open Source	Nov 2023
Workshop with Lely - TNO-ESI visited the Lely headquarters in Maassluis. This company is currently building autonomous robots for dairy farms. These systems are highly complex and have to deal with a harsh and unpredictable environment. In the context of farms reliability and	March 25th, 2024

Dissemination Description	Date
robustness, as well as human/cow safety is of utmost importance. One of the big challenges the growing organization faces is how to get technical people and how to get them trained. There is a complaint that there is hardly any systems engineering education at universities of applied sciences and academic universities in the Netherlands. Lely is also working on topics in which AI may play a role. There are investigations mentioned around animal behavior prediction, which could complement the work of domain experts. The safety challenge of autonomous robots is also addressed in the ASIMOV use case about the UUV (unmanned utility vehicle). There, an AI-enabled system is built to generate novel and crucial test cases for a vehicle (crossing pedestrians combined with sun glare, etc). The resulting challenging set of test cases can in future be used for certification purposes. The systems engineers at Lely are looking for best practices and knowledge in the applied research areas of AI and digital twinning. Next to that, they try to learn from successful companies that build AI-enabled products. However, we concluded together: there are hardly any! Therefore, the ASIMOV 'cookbook' (a collection of best practices, experiences and guidelines) is a source of information the systems engineers are really looking forward to.	
Workshop with CBoost - TNO-ESI met with AI consultancy company CBoost (https://cboost.nl) to discuss the ASIMOV results and learn more about CBoost. CBoost provides AI solutions on computer vision, ML, digital twinning, robotics, IoT, and industrial automation software. CBoost works closely with SmartRobotics to provide robots to Vanderlande used in item picking, stacking and unstacking parcels. Considering the ASIMOV results, CBoost is interested in learning more about the ASIMOV 'cookbook' (a collection of best practices, experiences and guidelines). They are also very interested in AI in context of systems engineering, and the link to digital twinning. We identified multiple shared challenges, and are taking follow-up actions to setup further collaboration(s).	April 10th, 2024
TUE	
2 contributions have been submitted, accepted, and presented to the CDC 2023, which is a leading control conference focussing on theory. The contributions will be printed in a conference proceedings issue. The first contribution is focused on Bayes' filtering while assuming a Fourier basis, while the second is concerned with extending the Gaussian process regression framework to the case where the function evolves with time through a dynamical model.	December 2023
1 abstract has been submitted and presented at the 42nd Benelux Meeting on systems and control. The content of the submission is the application of Bayesian optimization on the calibration of the electron microscope.	March 2023
1 contribution has been submitted to the ECC 2024, which is a leading control conference based in Europe. The contribution is focussed on improving the convergence speed of Q-learning under certain assumptions.	November 2023
1 contribution has been submitted to the ACC 2023, which is a leading control conference focussing on applications. The contribution is concerned with the application of Bayesian optimization to the electron microscope.	October 2023
2 abstracts have been submitted, accepted, and presented end of March to the 43rd Benelux Meeting on systems and control. The content of the first submission is combining prior knowledge and data samples in policy evaluation. The content of the second submission is faster quadratic Q-learning by exploiting linear matrix inequalities.	March 2024
2 contributions have been submitted to the CDC 2024 (the notification of acceptance is in July 2024). The first contribution is on data-efficient projected Q-learning using semidefinite programming, while the second is concerned with combining prior knowledge and data samples in policy evaluation.	March 2024

Table 6 - Dissemination Results of Academic and Research Partners

4.3 Joint Dissemination Results

Partners	Dissemination Description	Date
TNO	Draft Wikipedia page has been created (in review by Wikipedia).	Jan2022
DLR	Project has been created on ResearchGate: https://www.researchgate.net/project/ASIMOV-ITEA	July 2022
AVL	ASIMOV public website launched: www.ASIMOV-project.eu	May 2022
DLR, TNO, AVL, Liangdao, Triangraphiscs, CQM	Accepted workshop paper for TwinArch-workshop at ECSA 2023. Architecture for DT based RL of Cyber Physical Systems	Sep 2023
DLR, TNO	ITEA PO days poster exhibition	Sep 2023

Partners	Dissemination Description	Date
DLR, TNO	ESI Symposium poster exhibition, vehicle in the loop demonstrator and AI maturity assessment for audience participation	April 2024

Table 7 - Joint Dissemination Results

In the table above, items are in grey as they are not the final results, but intermediate results.

4.4 Number of dissemination results (KPI in PPR – target: 30)

M6	6
M12	3
M18	4
M24	4
M30	10
M36	10

Table 8 - Number of dissemination results

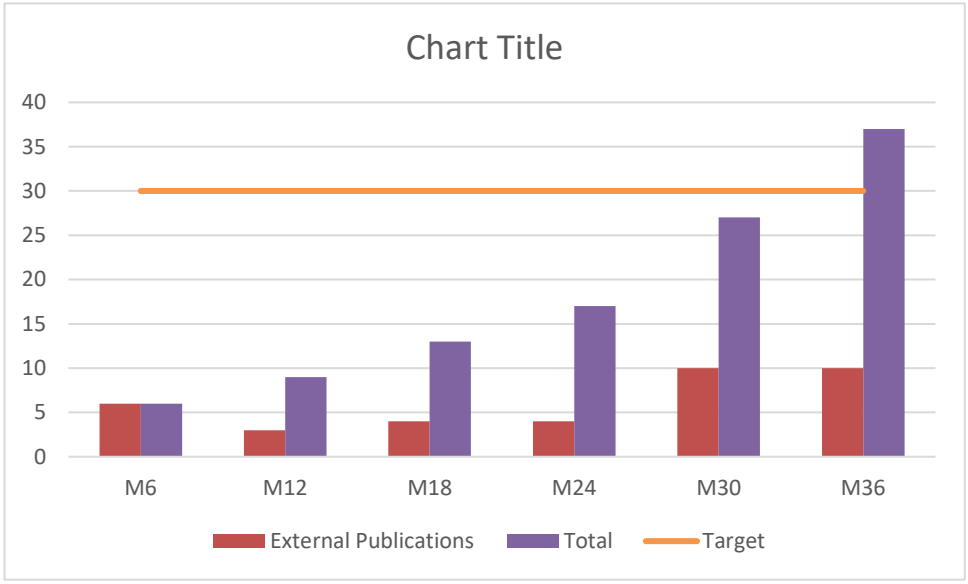

Figure 1 – Number of dissemination results Chart

5 Terms, Abbreviations and Definitions

Table 9 - Terms, Abbreviations and Definitions

AI	Artificial Intelligence
ASIMOV	AI training using Simulated Instruments for Machine Optimization and Verification
CPS	Cyber Physical Systems
DQN	Deep Q(Quality) Network
DT	Digital Twin
EM	Electron Microscope
FPP	Full Project Proposal
HW	Hardware
ML	Machine Learning
RL	Reinforcement Learning
SW	Software
TEM	Transmission Electron Microscope
UUV	Unmanned Utility Vehicle
WP	Work Package

6 Bibliography

[1] ASIMOV-consortium, *ASIMOV - Full Project Proposal,* 2020.