



**software framework for runtime-Adaptive and secure
deep Learning On Heterogeneous Architectures**

Project Number 780788

Project Acronym ALOHA

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Brief description:

This document reports the exploitation activities conducted in the ALOHA project during the first period, from January 2018 (M1) to June 2019 (M18), in Tasks T6.1 and T6.2.



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¹ The participation of CA TECHNOLOGIES DEVELOPMENT SPAIN SA (CA) has been terminated on May 9th, 2019.

² UNIVERSIDAD POMPEU FABRA (UPF) has been added as new beneficiary on May 29th, 2019.

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1 Executive Summary

This deliverable provides the first report on the exploitation activities carried out within the ALOHA project over the first 18 months. It enumerates the different activities performed according to the first exploitation plan (D6.1). The reported exploitation activities are aligned with the ALOHA timeline and the appropriate results in the different phases of the project.

The actions performed in WP6 during the first 18 months of the project were mainly focused on:

- monitoring the different markets impacted by ALOHA to detect any possible change in needs and trends,
- organizing the key outcomes of the project (mainly provided at individual level) into distinct type of key exploitable results (KRs),
- identifying individual exploitation strategies from each partner of the consortium,
- on preparing the ground for fostering the adoption of the ALOHA toolflow once available as a compact and integrated framework.

In the reported period, the industrial partners of the Consortium started using the project results to develop new products/services, and interacted with their customers and stakeholders to investigate the possibility of including the ALOHA methodologies in their products/processes. Some of the Key Exploitable Results, obtained from the work performed in the different work packages and collected in D6.1, have been completed and released as open-source in the ALOHA Gitlab repository. ALOHA partners have also attended target events to present the advantages of using ALOHA to potential stakeholders and customers, and have organized seminars, tutorials and workshops, engaging SMEs and mid-range software development companies.

All the ALOHA partners have contributed to this deliverable.

1.1 Relationships with other deliverables

This document relates to the following deliverables:

- D6.1 Exploitation plan and D6.2 Exploitation plan – First update, submitted respectively at M4 and M18.
- D6.3 Exploitation plan – Final update which will be submitted at M36.
- D6.5 Report on the exploitation activities - Update, which will update this report at M36.

This deliverable has been prepared together with deliverable *D7.5 “Dissemination and communication report”* to assure that both reports are aligned and complementary.

1.2 Acronyms and abbreviations

Acronym	Meaning
AI	Artificial Intelligence
AP-SoC	All Programmable System on Chip
B2B	Business to Business
CNN	Convolutional Neural Network
CSDF	Cyclo-Static Dataflow
DICOM	Digital Imaging and COmmunications in Medicine
DL	Deep Learning
DNN	Deep Neural Networks
DSE	Design Space Exploration
DSP	Digital Signal Processing

FPGA	Field-Programmable Gate Arrays
GA	Genetic Algorithm
IoT	Internet of Things
IPR	Intellectual Property Right
KPI	Key Performance Indicator
KR	Key exploitable Result
ML	Machine Learning
NDA	Non-Disclosure Agreement
ONNX	Open Neural Network Exchange
RTO	Research and Technology Organisation
TE	Training Engine
WP	Work Package

2 Summary of the exploitation plan

The consortium has elaborated an Exploitation Plan by month M4 of the project (deliverable D6.1) and an updated version of it at M18 (deliverable D6.2). We can summarize the content of the exploitation plan as:

- A description of the ALOHA business ecosystem, identifying the main stakeholders that can be impacted by ALOHA or that can have an impact in ALOHA:
 - Customers: the markets utilizing ALOHA technology.
 - Engineers: the actual users of the ALOHA tools (developers, design automation users, data scientists, researchers, students, etc.).
 - DL Architecture: the different neural network architectures that are widely used by practitioners.
 - DL Frameworks: the multiple open source frameworks for DL.
 - Infrastructure: the hardware platforms where the DL algorithms will be trained.
 - Devices: the low-powered devices where the DL algorithms will be deployed.
- An in-deep market analysis of each identified stakeholder. These markets are being continuously monitored by partners across the project timeline in order to detect new trends, new competitors or new possibilities;
- The identification of a set of project Key Results susceptible to be exploited as open source or commercial distributions. For each of them a description of the technical innovation, the potential of the results in the related market and the added value is provided;
- A market-oriented exploitation strategy for each partner of the consortium: use-case providers, academic and RTO partners, and industrial partners.
- The identification of a set of events to be attended by the ALOHA partners to verify the potential market penetration of their results.
- A preliminary discussion on the distribution of IPR, taking into consideration the work flow and developments foreseen by the end of the project.

The ALOHA exploitation plan classified the actions to be put in place, individually and jointly, by ALOHA partners to guarantee a concrete impact and to support the largest adoption of the project results and achievements in industry practice and future research. The exploitation activities to be performed are tightly aligned with all ALOHA WPs, but specially with WP7-Dissemination and with initiatives for communicating and disseminating the outcomes of ALOHA.

For more information about the plan, please refer to deliverable D6.2 – Exploitation Plan – First update.

3 Status of Key Results

At month M4, as reported in the first exploitation plan (deliverable D6.1), the Consortium has identified 12 Key project exploitable Results (KRs) in the form of concrete tools/solutions/methodologies, defining also the strategy on how to exploit them in the project. The list of KRs has been then updated at M18, in the updated version of the plan, D6.2. In this section, we report the status of the development of these KRs, summarizing for each of them the main achievements up to the reporting period (Month 1-18).

Table 1: Status of ALOHA exploitable results

KR1: ALOHA tool flow	
Description of the exploitable result	An integrated tool flow that tries to make the design of DL applications and their porting on embedded heterogenous architectures as efficient as possible. The tool considers hardware-related variables, security, power efficiency and adaptivity aspects during the whole development process, from pre-training hyperparameter optimization and algorithm configuration to deployment.
Partners involved	ALL
% complete	50%
Main achievements	The toolflow is capable of evaluating and exploring different algorithm configurations and different ports on three reference architectures. Testing has been performed so far on generic and use-case related datasets.
Relevant WPs and Tasks	WP1, Task 1.1, 1.2 and 1.3
Relevant deliverables submitted	D1.1, D1.2, D1.4, D1.5 and D1.6
Released as open source	Yes (working version not including proprietary satellite tools). Release as open-source under a liberal license (BSD, Apache, or equivalent).
KR2: DNN approximation tool for parsimonious inference	
Description of the exploitable result	A library capable of processing an input DNN topology, described in ONNX format and producing one or more versions of the same DNN quantized and pruned to meet given memory footprint constraints.
Partners involved	ETHZ
% complete	80%
Main achievements	The tool is able to process a state-of-the-art MobileNet network pretrained on ImageNet with full precision and transform it into a 5b-weight, 4b-activation network with less than 3% loss on ImageNet top-1 accuracy. It is also primed to process DNNs generated by the rest of the ALOHA toolflow in ONNX format and evaluate their accuracy with a naïve quantization scheme.
Relevant WPs and Tasks	WP2, Task 2.3
Relevant deliverables Submitted	D2.1, D2.2 and D2.3
Released as open source?	Not yet – will be released under a liberal license (BSD, Apache, or equivalent) on a public server or GitHub repository.

KR3: Approximated DNNs for industry-standard benchmark problems	
Description of the exploitable result	A set of pretrained examples of quantized DNNs targeting industry standard benchmark problems.
Partners involved	ETHZ
% complete	60%
Main achievements	Various quantized versions of VGG-16 on CIFAR-10, MobileNet on ImageNet available. Currently working on YOLO, SSD networks.
Relevant WPs and Tasks	WP2, Task 2.3
Relevant deliverables submitted	D2.1, D2.2 and D2.3
Released as open source?	Not yet – code and pretrained weights will be released under a liberal license (BSD, Apache, or equivalent) on a public server or GitHub.
KR4: CNN-to-DataFlow model conversion tool	
Description of the exploitable result	The CNN-to-Dataflow model conversion tool automatically generates a live and consistent Cyclo-Static Dataflow (CSDF) model, from an input Deep Neural Network (DNN) model. The generated CSDF model is utilized in ALOHA project for DNN model evaluation in terms of memory, energy, and performance (WP2) and integration with Sesame-based DSE (WP2-WP3 integration).
Partners involved	UL and UvA
% complete	100%: The tool is ready and tested on the DNN models from the ONNX models Zoo. The tool is embedded in the espamAI open-source tool, and available on https://gitlab.com/aloha.eu/power_perf_sources
Main achievements	The tool allows to convert a DNN into a functionally-equivalent CSDF model, and, subsequently, apply the existing embedded systems frameworks and methods for DNNs. To the best of our knowledge, there is no other existing tool, providing such a conversion.
Relevant WPs and Tasks	WP2, WP3, Tasks 2.1, 2.4, 3.1 and 3.4
Relevant deliverables submitted	D2.1, D2.2, D3.1, D3.2
Released as open source?	Yes, under a permissive software license (BSD-style license) with minimal requirements about how the software can be used and redistributed.
KR5a: Design Space Exploration engine	
Description of the exploitable result	Implementation of a Design Space Exploration (DSE) tool, based on Genetic Algorithms (GA), that allows for automatically exploring possible neural network topologies and various network hyperparameters (such as number of neurons, kernel size and strides for a convolutional layer) and, towards this end, it presents a few selected best solutions which satisfy pre-defined criteria.
Partners involved	UL and UvA
% complete	60%
Main	First version of DSE tool ready and operational, including partial integration with

achievements	satellite tools.
Relevant WPs and Tasks	WP2, Task 2.1
Relevant deliverables submitted	D2.1, D2.2 and D2.3
Released as open source?	Not yet – will be released under a permissive software license (BSD-style license) with minimal requirements about how the software can be used and redistributed.
KR5b: Training engine	
Description of the exploitable result	Implementation of a tool that allows to train DNN in fast (for rapid prototyping) and full mode (as full-fledged version for final use); ready for testing by use-case providers.
Partners involved	SCCH
% complete	c.a. 70%
Main achievements	Implementation of a tool within the Training Engine (TE) with ability of training networks passed by the Design Space Exploration (DSE) engine in ONNX format and hand-optimized DNN networks. Additional feature of the tool is the estimation of network training quality via fast (rapid prototyping) mode.
Relevant WPs and Tasks	WP2, Task 2.1
Relevant deliverables submitted	D2.1, D2.2 and D2.3
Released as open source?	Not yet – will be released under a permissive software license (BSD-style license) with minimal requirements about how the software can be used and redistributed.
KR6: Security evaluation of deep neural networks and mitigation strategies	
Description of the exploitable result	Implementation of a tool that is able to evaluate the security/robustness of CNNs under worst-case and random perturbations of the input data. The tool can operate in fast or slow evaluation modes, allowing the user to significantly speed up the evaluation without losing too much precision. An online demonstrator is available at: https://www.pluribus-one.it/research/sec-ml/demo/ Identification of suitable mitigation strategies based on adversarial training or specifically-regularized loss functions (to be optimized by the training engine).
Partners involved	PLURIBUS
% complete	70%
Main achievements	Implementation of a tool for security/robustness evaluation of deep learning models, along with an online demonstrator. Definition of mitigation strategies. ONNX loading, docker container development.
Relevant WPs and Tasks	WP2, Task 2.2
Relevant deliverables submitted	D2.1, D2.2 and D2.3

Released as open source?	Not yet – will be released under a permissive software license (BSD, Apache, or equivalent) with minimal requirements about how the software can be used and redistributed.
KR7: Dataset bias detection	
Description of the exploitable result	Tool to measure biases in input data and learned by the model that can potentially reflect in algorithmic discrimination.
Partners involved	UPF
% complete	5%
Main achievements	New approach for the solution after the new arrangement of the consortium. Main design of the solution has been created, research actions are being executed before implementing and integrating the module with the rest of the ALOHA toolbox.
Relevant WPs and Tasks	WP2, Task 2.2
Relevant deliverables submitted	D2.2
Released as open source?	Not yet – will be released under a permissive software license (BSD, Apache, or equivalent)
KR8: Post-Training tool for Parsimonious Inference	
Description of the exploitable result	A tool that is able to optimize CNNs by applying automated static and dynamic pruning.
Partners involved	IRIDA
% complete	70%
Main achievements	Read and write ONNX, Automatic transformation of a CNN model, docker container development.
Relevant WPs and Tasks	WP3, Task 3.2
Relevant deliverables submitted	D3.1, D3.2 and D3.3
Released as open source?	No.
KR9: Sesame tool for application partitioning & mapping exploration	
Description of the exploitable result	Sesame modeling and simulation framework that allows for mapping DSE, in which different mappings of CSDF-based DNNs (as a result of the translation in KR4) can be explored for different DNN network granularities and for different underlying (modelled) multi-core platforms.
Partners involved	UvA
% complete	70%
Main achievements	Mapping exploration in Sesame using (small to medium-sized) CSDF-based DNNs is operational.
Relevant WPs and	WP3, Task 3.1

Tasks	
Relevant deliverables submitted	D3.1, D3.2 and D3.3
Released as open source?	Not yet – will be released under a GPL v2 (or higher) license.
KR10: Architecture Optimization Workbench	
Description of the exploitable result	Scalable mathematical programming based DSE tool addressing ALOHA use cases.
Partners involved	IBM
% complete	60%
Main achievements	Standalone version of the mathematical programming based DSE tool. Proof of concept for scalable optimization of dynamic systems.
Relevant WPs and Tasks	WP3, WP1, WP5
Relevant deliverables submitted	D3.1, D3.2 and D3.3
Released as open source?	Not yet – will be released under a permissive software license (BSD-style license) with minimal requirements about how the software can be used and redistributed.
KR11: Automated adaptive middleware generation/customization	
Description of the exploitable result	A utility automating the generation/customization of a runtime environment, implementing optimal management of a computing hardware architecture described by an adequate model. The utility will reduce power consumption and improve performance considering the specific features of the target hardware architecture and using the related architecture management knobs available at runtime.
Partners involved	UNICA, ETHZ, UNISS, ST-I
% complete	70%
Main achievements	Porting of the selected algorithm configuration and mapping automated for three reference platforms. Code generation utility and customizable library are available. Runtime management technique implemented and tested on single-core low-power RISC processor.
Relevant WPs and Tasks	WP4, Tasks 4.1, 4.2, 4.3 and 4.4
Relevant deliverables submitted	D4.1, D4.2, D4.3
Released as open source?	Part of the utilities will be released as open source. E.g. NEURAghe code, libraries, code generators released as open-source under a liberal license (BSD / Apache).
KR12: Other key exploitation items – NEURAghe reference platform	
Description of the exploitable result	NEURAghe is a Zynq-based heterogeneous architecture accelerating CNNs used to test and evaluate the support provided by the ALOHA tool flow to developers in implementing DL applications on FPGA-based platforms.
Partners involved	UNICA and ETHZ

% complete	100%
Main achievements	State-of-the-art performance on CNN execution on different AP-SoCs with different cost and power figures. Software programmability. Complete integration inside ALOHA toolflow.
Relevant WPs and Tasks	WP4, Task 4.1
Relevant deliverables submitted	D4.1, D4.2, D4.3
Released as open source?	Yes, under a liberal license (BSD / Apache).

4 Completed exploitation activities

In this Section we describe how the ALOHA consortium has exploited the results obtained so far and we report the exploitation activities carried out among the partners to ensure an effective and concrete utilization of the project outcomes, according to what was planned in deliverable D6.1.

4.1 Industrial exploitation activities

In this section we report all the exploitation activities carried out by the ALOHA industrial partners in Task 6.2.

4.1.1 Products/Service development

We report in this section new product/service developments or integration in existing products/ product developments started by the industrial partners within ALOHA in the period from M1 to M18.

- **ST-I** –STMicroelectronics has developed, and is improving, a tool chain for the deployment of CNNs on STM32 embedded platforms. The tool chain is named x-Cube-AI and it is part of the Open Development Environment of ST for the STM32 platforms, named Cube. The toolflow is publicly available at the following address:
https://www.st.com/content/st_com/en/products/embedded-software/mcu-mpu-embedded-software/stm32-embedded-software/stm32cube-expansion-packages/x-cube-ai.html
 STMicroelectronics is also conducting the development of an hardware accelerated embedded platform for the efficient execution of CNNs. The development started from the R&D SoC named Orlando, that embeds eight accelerators coupled with 16 DSPs and a central ARM M0 core. The hardware accelerators are under development for the improvement of performances and the extension of the coverage of the variety of networks available. In the ALOHA project this solution is evaluated and improved with the support of the use cases defined in the project and the components of the ALOHA toolflow. As announced by ST (<http://investors.st.com/static-files/e37c5f31-658b-4195-8359-481b9568ce05>) the company plans to release products including the support of such accelerators. The development is also supported by the results obtained in the ALOHA project.
- **IBM** – IBM Research performed more than twenty meetings with internal and external executives to find internal technology catchers (in IBM business units) or external customers for design space exploration technologies developed in ALOHA. Four patent disclosures are in the filing process. Based on the successful proof of concept, IBM is in process of publishing the scalable mathematical programming optimization engine for dynamic systems in open source under Apache 2.0 license.
- **PKE** - Within the activities of the ALOHA project, to support data preparation process, PKE has started the development of a data management tool for data annotation and maintenance. This tool, together with the ALOHA Toolflow will be part of the PKE’s workflow for creating deep learning-based applications. This tool is already available as a prototype. PKE has also developed tools to concatenate different datasets. We have also initiated the creation of a tool set, based on the Unity game development platform, to create synthetic data for training networks for behavior analysis.
- **IRIDA** – IRIDA has started the development of a standalone tool, facilitating the optimization of CNNs by applying the Post-PI technique. The nuts and bolts of the envisioned tool are worked out in the context of ALOHA. In addition, part of its overall architecture and functionality, has been inspired from ALOHA tool-flow integration logic. IRIDA takes also care about the future commercialization of the technology by taking actions for the protection of any new IPs and also by developing the necessary backbone infrastructure (cloud technology).
- **PLURIBUS** - Pluribus One has open sourced KR6 as a library for assessing the security/robustness

of deep learning algorithms and develop suitable mitigation strategies. The company has started exploiting the library as a fundamental asset in its commercial products towards the development of safe and explainable deep learning technologies for cybersecurity. In particular, Pluribus One has started integrating the developed tool into two commercial products. The first is a webpage phishing detection tool, which analyzes both the textual and visual content of phishing webpages using machine learning. The second is a mobile malware detector for Android. In both cases, cybercriminals may have clear incentives to bypass the detection algorithms, and thus the development of secure and robust learning algorithms is of uttermost importance.

- **REPLY** - REPLY network of highly specialized Companies offer artificial intelligence and machine learning solutions and consultancy services tailored on customers' business needs (<https://www.reply.com/en/topics/artificial-intelligence-and-machine-learning/intelligence>). REPLY started to evaluate the integration of ALOHA Toolflow in its current process to support developers in identifying an optimal deep learning algorithm customized for a target platform. This is expected to significantly decrease associated time and costs and so to improve the time to market.
- **MaxQ-AI** – MaxQ developed a standalone tool for the conversion of the CT output data (named DICOM data) and truthing data to the ALOHA input specifications. This tool will be a part of any ALOHA Toolflow-based MaxQ computational flow.

4.1.2 Stakeholder engagement

We reported in this section information about stakeholder engagement and strategic meetings held with customers by the ALOHA industrial partners within the reported period.

- **ST-I** – In the reported period, ST-I prepared and started several research projects for the implementation and deployment of edge computing platforms into relevant use cases, specifically for the industrial sector. In particular the application of the CNN based devices will be used as autonomous sensors for industrial environment, for the safety of the operators and the improvement of the industrial plant efficiency. Two main product divisions of STMicroelectronics have been involved in the review of the results of the project and the related internal developments. The main areas of development considered are the IoT domain, considering in particular the industrial sector, and the automotive domain, where the applications of CNN based edge computing are many. The use of the ALOHA toolflow will enable the actual stakeholder to develop their own applications and deploy them on the ST platforms. The variety of sensors that can be used on ST platforms will also enable different classes of applications. The emerging market of AI on the edge attracts a lot of small new companies that need to rapidly develop new applications without a relevant experience with the embedded devices. ST-I discussed with several of these companies in order to create synergies, with the support of the ALOHA toolchain as bridge between the two levels, of the applications and the platform.
- **IBM** - In the reported period, IBM met and initiated an engagement process with customers from transportation and industrial sectors and internal business units in IoT and cloud sectors. Running AI algorithms on edge is critical for all these customers and ALOHA scalable and robust optimization technologies with potential 100x improvement in quality, scalability or speed provide a significant competitive advantage for them. Several leads have been started during IBM Think! 2019 conference.
- **PKE** - In the reported period, PKE has started the implementation of about 30 projects in the video surveillance segment. During this period, PKE's product management department, together with our customers, has continuously analyzed the need and development of different artificial

intelligence-based solutions, including the usage of smart cameras with embedded video analytics and artificial intelligence. In specific projects, PKE has explicitly observed the potential benefits of the ALOHA Toolflow. This concerns, for instance, the expansion of existing systems to be able to detect very specific new classes of objects present in some specific critical infrastructures. Here, the usage of the ALOHA Toolflow and its components would speed-up the process of algorithm optimization. Even more, with an improvement of the accuracy expected by the utilization of artificial intelligence solutions, PKE estimates an extensive reduction in costs of service and maintenance activities, such as system re-parameterization. Especially for difficult situations, where it is not possible to control the environment, as for instance in installations with old cameras, it is not rare that efforts from several weeks to a few months of fine-tuning work is needed. In the last two years PKE has dealt with some of such difficult cases. In such situations, the analysis performed has shown that having a workflow based on the ALOHA Toolflow, that can automatically analyze collected data and generate the optimal solution, could save PKE up to 80% of direct costs. Not to mention the benefits of higher customer satisfaction. In this period, PKE has also observed and influenced an increasing customer's awareness of embedded edge solutions in contrast to server-based solutions. Also, here PKE noted that, depending on the availability of cameras with deep learning accelerators, the Toolflow will help their business by generating hardware aware optimized algorithms. Please note that, as such projects involve critical infrastructure, such as correctional facilities and central banks, PKE cannot disclose any specific information. PKE has also continuously monitored the developments of the embedded video analytics market and is analyzing utilization of products announced by our partners such as Hikvision, Bosch and Axis.

- **IRIDA** - IRIDA is continuously and actively promoting the tool under development, to its various partners during B2B collaborations and also promoting the technology as a future product to various international trade-shows. Due to various NDAs that IRIDA usually signs, disclosure of details of the name of business partners or any other project details is restricted and therefore only general qualitative information is reported here. In general, there is a positive feedback, while any doubts or suggestions for changes or improvements are continuously evaluated through this process. In general, there is a good acceptance of the related technology, while it seems that the involvement of the company with a cutting-edge technology, such is this of ALOHA, is very beneficial for the image and the business cases of Irida Labs.
- **PLURIBUS** - Pluribus One aims at developing secure and robust learning algorithms for cybersecurity tasks, including web, network and endpoint security, with the goal of reducing the risks associated to targeted cyberattacks. The company is constantly promoting this vision, along with the open-sourced tool developed within ALOHA, in B2B collaborations and meetings with its partners and stakeholders, collecting positive feedback and suggestions for improvements. Pluribus One is also seeking to engage new stakeholders and customers by encouraging the use of the security evaluation tool as a standalone module for evaluating robustness of deep learning models. To further favor this process, in the reported period, the company has released a web demonstrator, publicly available at the following link: <https://www.pluribus-one.it/research/sec/ml/demo/>.

The demonstrator aims to show how vulnerable deep-learning algorithms can be, and to motivate the use of robust algorithms, especially in security-sensitive settings. The web page has been accessed more than 600 times since January 2019. These interactions, along with the dissemination actions performed in the context of the ALOHA project, have helped Pluribus One in consolidating existing collaborations and developing novel business opportunities.

- **REPLY** - In the period from M1 to M18, REPLY continuously monitored the evolutions of the

speech recognition and natural language processing market, as well as the Industry 4.0, and actively promoted ALOHA through its network of contacts. In this phase, REPLY aimed at creating awareness of the project objectives and initial results, both internally, towards other business units of the Company, and externally, especially towards customers network and industrial associations. To this end, REPLY organized a seminar (see Table 2), where the initial version of demonstrator was shown and ALOHA leaflets were distributed to partners, customers and peers in different events where REPLY attended (as reported in Table 5). As the feedback was very positive and the interest high we plan in the next phase to actively engage with selected stakeholders by means of videos, prototypes and dedicated meetings.

- **MaxQ-AI** - In the last couple of months, MaxQ's computation flow has shifted a more CNN-based than computer-vision-based computational flow. Hence, with the increase in the number of CNNs needed to run during the computational flow the latency is expected to increase. Thus, we expect the ALOHA tool to help us cope with the strict latency requirements from our channel partners. To improve the inference latency, we at MaxQ will utilize the specialized Toolflow capabilities in pruning and parsimoniousness to create a better and faster model.

4.1.3 Organization of Seminars and Tutorials

We report in this section information about seminars and tutorials organized by the ALOHA industrial partners in the period from M1 to M18.

Table 2: List of organized Seminars and Tutorials

Type of Activity	Tutorial on adversarial machine learning and on the vulnerability of machine-learning during EUSIPCO 2018, 26th European Signal Processing Conference.
Organized by	PLURIBUS
Description	Half-day Tutorial on Adversarial Machine Learning (https://www.pluribus-one.it/sec-ml/wild-patterns), periodically held by Pluribus One during several top conferences and events on machine learning and computer vision. The secure machine-learning algorithms and the related security assessment procedures defined within the ALOHA project have been presented by Battista Biggio and Fabio Roli during this edition of the tutorial.
Target/Audience	Machine Learning/Deep Learning/Cyber-security communities.
Date and Place	September 3, 2018, Rome, Italy.
Number of attendees	About 40.
Type of Activity	Tutorial on adversarial machine learning and on the vulnerability of machine-learning during ECCV 2018, European Conference on Computer Vision.
Organized by	PLURIBUS

Description	Half-day Tutorial on Adversarial Machine Learning (https://www.pluribus-one.it/sec-ml/wild-patterns), periodically held by Pluribus One (PLURIBUS) during several top conferences and events on machine learning and computer vision. The secure machine-learning algorithms and the related security assessment procedures defined within the ALOHA project have been presented by Battista Biggio and Fabio Roli during this edition of the tutorial. The goal of this tutorial was to raise awareness on the security of deep learning algorithms.
Target/Audience	Machine Learning/Deep Learning/Cyber-security communities.
Date and Place	September 8, 2018, Munich, Germany.
Number of attendees	About 30.
Type of Activity	Tutorial on adversarial machine learning and on the vulnerability of machine-learning during ACM CCS 2018, 25th ACM Conference on Computer and Communications Security.
Organized by	PLURIBUS
Description	Half-day Tutorial on Adversarial Machine Learning (https://www.pluribus-one.it/sec-ml/wild-patterns), periodically held by Pluribus One during several top conferences and events on machine learning and computer vision. The secure machine-learning algorithms and the related security assessment procedures defined within the ALOHA project have been presented by Battista Biggio during this edition of the tutorial.
Target/Audience	Machine Learning/Deep Learning/Cyber-security communities.
Date and Place	October 15, 2018, Toronto, Canada.
Number of attendees	About 30.
Type of Activity	Tutorial on adversarial machine learning and on the vulnerability of machine-learning during Winter School on Quantitative Systems Biology: Learning and Artificial Intelligence.
Organized by	PLURIBUS
Description	Tutorial on Adversarial Machine Learning (https://www.pluribus-one.it/sec-ml/wild-patterns), periodically held by Pluribus One during several top conferences and events on machine learning and computer vision. The secure machine-learning algorithms and the related security assessment procedures

	defined within the ALOHA project have been presented by Battista Biggio during this edition of the tutorial.
Target/Audience	Machine Learning/Deep Learning/Cyber-security communities.
Date and Place	November 15-16, 2018, Trieste, Italy.
Number of attendees	About 80
Type of Activity	Tutorial on adversarial machine learning and on the vulnerability of machine-learning during NeCS PhD Winter School, Fai della Paganella, Trento.
Organized by	PLURIBUS
Description	Tutorial on Adversarial Machine Learning (https://www.pluribus-one.it/sec-ml/wild-patterns), periodically held by Pluribus One during several top conferences and events on machine learning and computer vision. The secure machine-learning algorithms and the related security assessment procedures defined within the ALOHA project have been presented by Battista Biggio during this edition of the tutorial.
Target/Audience	Machine Learning/Deep Learning/Cyber-security communities.
Date and Place	February 20, 2019, Fai della Paganella, Italy.
Number of attendees	About 27.
Type of Activity	Seminar on “Deep learning applied to command recognition in smart industry”.
Organized by	REPLY
Description	Seminar organized and hosted by Santer Reply to share knowledge with colleagues of different business units within the Company. Deep learning techniques and opportunities for application in smart industry have been presented by Cristina Chesta and Paolo Diotti.
Target/Audience	Deep Learning and Embedded Systems communities.
Date and Place	June 13, 2019, Torino, Italy.

Number of attendees	About 20.
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4.2 Academic and RTO exploitation activities: technology and knowledge transfer

Academic and RTO exploitation plans and actions are naturally extremely different from industrial ones. While companies are more focussed on the creation of new business opportunities and on improving tools and platforms to strengthen their market positioning, the main objective of research institutes is converting knowledge into socio-economical benefits.

Direct commercialization of results is not the focus of the academic and RTO partners in ALOHA consortium, who have been more focussed during these first 18 months of the project, and will continue to be also in the next 18 ones, on exploiting the results internally to improve the quality of teaching and make sure that students are educated on hot and recent research topics and industrial trends, and on facilitating the knowledge flow, to attract external potential users of the developed technologies.

4.2.1 Bachelor/MSc/PhD thesis works

This section reports on partners' exploitation activities related to assignments of thesis about ALOHA topics.

Table 3 - List of theses within ALOHA topics

Type	Bachelor Thesis
Title/Topics	3D Modeling for Labeled Synthetic Video Dataset Generation
Leading Institute	Technical University Vienna with the support of PKE
Status	Ongoing (started 01/03/2019)
KR	ALL
Type	Master Thesis
Title/Topics	The development of ONNX to PyTorch converter supporting algorithm-level Design Space Exploration
Leading Institute	UNICA
Status	Ongoing (started on 10/12/2018)
KR	ALL
Type	Master Thesis

Title/Topics	Accelerating Convolutional Neural Networks on a low-cost heterogeneous processing platform
Leading Institute	UNICA
Status	Completed on 14/11/2018
KR	KR12
Type	Master Thesis
Title/Topics	Integrating Support for Parsimonious Inference on a CPU-FPGA based CNN Inference Accelerator
Leading Institute	UNICA
Status	Completed on 17/04/2019
KR	KR8, KR12
Type	PhD Thesis
Title/Topics	Modeling and optimization of FPGA-based CNN accelerators.
Leading Institute	UNICA
Status	Ongoing (started on 01/10/2018)
KR	KR, KR12
Type	PhD Thesis
Title/Topics	Design Space Exploration Methods and Techniques for Deep Learning on Embedded System Architectures
Leading Institute	UvA
Status	Ongoing (started on 01/2018)
KR	KR5a, KR9
Type	PhD Thesis
Title/Topics	Software Framework for Runtime-Adaptive and secure Deep Learning on Heterogeneous Architectures.

Leading Institute	UL
Status	Ongoing (started on 01/2018)
KR	KR4, KR5

4.2.2 Teaching/training services

This section reports on partners' exploitation activities related to lab assignments or student projects related with ALOHA topics in specific courses.

- **UvA** - A lab assignment, based on the ALOHA version of Sesame, will be developed for the UvA MSc-level course 'Embedded Software and Systems'. The number of attendees in this course is around 50-60.
- **UNICA** - Lab assignment about ALOHA's KWS use-case. Implementation on a Xilinx Z7010 device. MSc-level course 'Processor architecture and integrated systems'. The number of attendees in this course is around 15-20.

4.2.3 Organization of Workshops

ALOHA partners have experience in organizing conferences, tutorial and summer schools and put in place actions to exploit ALOHA results through these channels. These activities are in between dissemination and exploitation; therefore, you may also find some of them mentioned in D7.5.

ALOHA team organized/participated in 6 workshops, to internally and externally transfer project technologies. In the following table, we report some details on the activities organized within the exploitation strategy.

Table 4: List of organized workshops

Type of Activity	Organization of the 4th Workshop on Design of Low Power Embedded Systems (LP-EMS18).
Organized by	UNICA and ETHZ
Description	Paolo Meloni (UNICA) and Francesco Conti (ETHZ) organized the 4th Workshop on Design of Low Power Embedded Systems, co-located with ACM International Conference on Computing Frontiers 2018. The goal was to learn, network and discuss with professionals and experts working in the same thematic areas of research as ALOHA.
Target/Audience	Research institutions and industries in the fields of analytics, machine learning, and high-performance computing.
Date and Place	May 8 – 10, 2018, Ischia, Italy.
Number of attendees	About 20.

Type of Activity	SCCH internal workshop on “Deep Learning Basics in the Context of ALOHA”
Organized by	SCCH
Description	The intention of this Workshop was to share knowledge among different departments of SCCH (Computer Vision, Data Science for Industry 4.0, Software Analytics and Evolution) in the area of Deep Learning. The workshop included theory and practice. The event has been organized and hosted by SCCH - Software Competence Center Hagenberg GmbH.
Target/Audience	SCCH staff
Date and Place	January 30th, 2019, Hagenberg, Austria.
Number of attendees	15
Type of Activity	ALOHA internal workshop on “Deep Learning Basics in the Context of ALOHA”
Organized by	SCCH
Description	The intention of this Workshop was to share knowledge of SCCH in the area of Deep Learning with ALOHA partners. The workshop included theory, practice and master-classes. The event has been organized and hosted by SCCH - Software Competence Center Hagenberg GmbH.
Target/Audience	ALOHA partners
Date and Place	February 6th, 2019, Linz, Austria.
Number of attendees	About 15.
Type of Activity	Organization of the public Workshop “Deep Learning at the Edge - 1st ALOHA Workshop on Deep Learning and Embedded Systems”
Organized by	SCCH
Description	The ALOHA consortium organized its first public workshop dedicated to topics covered in the project development, such as Deep learning, Embedded systems, Security of Deep learning architectures. Speakers from Italy, Switzerland and Austria shared their expert knowledge and provided information about ALOHA

	<p>tool development.</p> <p>The event has been organized and hosted by SCCH - Software Competence Center Hagenberg GmbH.</p> <p>https://www.scch.at/en/kvs-news/deep-learning-at-the-edge</p>
Target/Audience	Austrian SMEs and mid-cap companies, research centers
Date and Place	February 7th, 2019, Linz, Austria.
Number of attendees	About 50.
Type of Activity	Talk on “ALOHA H2020 project: Training Engine”
Organized by	linz.ai - Data Science Meetup, SCCH involved
Description	<p>The intention of this talk is share more information about ALOHA tool and attract research community in Linz to the topic of ALOHA.</p> <p>https://www.meetup.com/linz-ai/events/257920864/</p>
Target/Audience	Research and development team in the area of machine learning and analytics.
Date and Place	February 26th, 2019, Linz, Austria.
Number of attendees	107
Type of Activity	Organization of the 5th Workshop on Design of Low Power Embedded Systems (LP-EMS19).
Organized by	UNICA and ETHZ
Description	Paolo Meloni (UNICA) and Francesco Conti (ETHZ) organized the 5th Workshop on Design of Low Power Embedded Systems, co-located with ACM International Conference on Computing Frontiers 2019. The goal was to learn, network and discuss with professionals and experts working in the same thematic areas of research of ALOHA.
Target/Audience	Research institutions and industries in the fields of analytics, machine learning, and high-performance computing.
Date and Place	April 30 – May 2, 2019, Alghero, Italy.

Number of attendees	About 20.
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4.2.4 Follow-up project / proposals

- H2020 EVISION proposal: The EVISION proposal aspired to combine embedded expertise across Europe and leverage it to develop next-generation of hardware and software components for efficient operation in edge applications with very limited energy budget to secure long-term superiority. UNICA contributed to strengthen EVISION use-cases and platforms by exploiting the experience and know-how acquired in ALOHA. The EVISION proposal was prepared in response to call “H2020-ECSEL-2019-2-RIA Edge computing” and submitted in May 2019. It is currently under evaluation.

4.3 Exploitation-oriented communication and dissemination activities

During the first 18 months of the ALOHA project, the consortium started to present achievements, POCs and tools, in several events. Exploitation activities targeting potential industrial stakeholders are devoted to increase the visibility of the ALOHA partners in the market in order to exploit project results. This is particularly important for all the consortium partners to increase exploitation opportunities during and after the project. All the completed activities targeting potential industrial stakeholder carried out during this period of the project, such as booths, fairs and events are presented in Table 5. Some of these activities are reported also in D7.5, since they are part of the dissemination strategy as well.



Figure 1. Exploitation-oriented events for ALOHA

Table 5: Exploitation-oriented events where the ALOHA partners have been present

Name of the event	Embedded World 2018
Who attended	ST-I
Description	Embedded World is the leading international fair for embedded systems. Every year at Embedded World the latest innovations in the embedded sector, ranging from construction elements through modules and full systems, operating systems, hard and software to services, are presented. In 2018 edition of the Embedded World, ST-I was present with a booth and Dr. Giuseppe Desoli gave a speak entitled

	<i>"A New Scalable Architecture to Accelerate Deep Convolutional Neural Networks for Low Power IoT Applications"</i> https://www.st.com/content/st_com/en/special-events/embedded-world-2018-post-event/embedded-world-2018-speeches.html
Target/Audience	Industrial Embedded System researcher and practitioners.
Date and Place	27 th February – 1 st March, Nurnberg (Germany)
Number of attendees	1K + exhibitors and 30K+ visitors
Name of the event	Embedded World 2018
Name of the event	Mobile World Congress
Who attended	CA and ST-I
Description	The Mobile World Congress is the most important mobile technologies trade fair in the world. This event attracts executives from the world's most influential mobile operators, device makers, app and software development companies, internet companies and organizations across a wide range of vertical industry sectors, as well as government delegations from across the globe. Both ALOHA partners took advantage of their presence in the event to discuss ALOHA research and potential outcomes with clients, partners and peers.
Target/Audience	Mobile community, App and Software Development Vendors, Consultancies and Broadcast, Media and Entertainment, Manufacturing and Automotive, emerging industries such as Virtual Reality/Augmented Reality
Date and Place	26 February – 1 March 2018, Barcelona (Spain)
Number of attendees	107000
Name of the event	DATE Conference
Who attended	UNICA, UvA, UL
Description	This event is the most important trade show and a technical conference on electronic system design and test in Europe. UNICA took advantage of the HiPEAC (European Network on High Performance and Embedded Architecture and Compilation) booth to discuss the ALOHA approach and its potential outcomes with designers, researchers and the main important vendors of tools for the design, development and test of Systems-on-Chip, IPs, Embedded Systems, ASICs

	and FPGAs.
Target/Audience	Academic and industrial research communities, designers, developers, executives, system design community, EDA (Electronic Design Automation) industries and IoT companies.
Date and Place	19 – 23 March 2018, Dresden (Germany)
Number of attendees	About 500 participants in total
Name of the event	Automation & Testing trade fair
Who attended	REPLY
Description	The Automation & Testing trade fair is dedicated to Industry 4.0, testing and measurements, innovative technologies, and robotics. REPLY attended the event to gather contacts and present ALOHA and Industry 4.0 use case to selected company decision-makers and technical managers from the target market.
Target/Audience	Automotive community, technical managers of manufacturing, electronics, aerospace industries, system integrators, developers.
Date and Place	18 – 20 April 2018, Turin (Italy)
Number of attendees	14432 visitors and 422 exhibitors
Name of the event	CA Built to Change Summit
Who attended	CA
Description	The Built to Change Summit brings together a small group of the world’s most influential media and industry analysts from key publications and firms, to hear from, and engage with CA executive team members, product development leadership and CA showcase customers and partners who are changing their industries. CA Strategic Research presented some of its most innovative projects. ALOHA was one of five projects being presented. This was a high impact event and a great opportunity for ALOHA, as more than a hundred of press releases were generated from the event.
Target/Audience	Technological press, general public.
Date and Place	5 June 2018, Santa Clara (USA)

Number of attendees	29 reporters from 13 countries.
Name of the event	Security Summit
Who attended	PLURIBUS
Description	Security Summit is an event dedicated to security information and information systems, which registered an amazing success during last years' editions thanks to in depth examinations on the most important technologies for ICT security and high value contents. The event is organized by CLUSIT, The Italian Association for Information Security and Astrea, Marketing and communication agency specialized in organizing events b2b. During the Summit, PLURIBUS ONE has briefly introduced the ALOHA project.
Target/Audience	Industrial stakeholders. General audience.
Date and Place	March 13-14-15, 2018, Milano (Italy).
Number of attendees	About 1200 participants in total.
Name of the event	Xchange 2018
Who attended	REPLY
Description	Annual appointment organized by REPLY to discuss main trends of innovation and new technologies. It was a good opportunity to share ALOHA objectives and results with company stakeholders and customers.
Target/Audience	Industrial stakeholders.
Date and Place	4-5 July 2018, Milan, Italy.
Number of attendees	+ 3000
Name of the event	SINNOVA Fair
Who attended	PLURIBUS
Description	SINNOVA is the most important Sardinian exhibition dedicated to innovation. It is organized every year in Cagliari. Innovative ICT companies and Universities

	present their products and the results of their research activities. During SINNOVA 2018, PLURIBUS ONE (represented by Davide Ariu, Matteo Mauri, and Luca Piras) presented its activities and the ALOHA project.
Target/Audience	Industrial stakeholders. General audience.
Date and Place	October 11-12, 2018, Cagliari, Italy.
Number of attendees	More than 1000 participants in total.
Name of the event	VISION 2018
Who attended	IRIDA
Description	VISION is the world's leading trade fair for machine vision. The who's who in the machine vision industry met in Stuttgart and presented an incomparable range of products and services: from sensors to processors, from cables to cameras, from software to illumination systems. ALOHA vision has been presented by IRIDA partner.
Target/Audience	Industrial stakeholders. General audience.
Date and Place	November 6-8, 2018, Stuttgart, Germany.
Number of attendees	11106 visitors
Name of the event	CES 2019
Who attended	ST-I
Description	CES is an annual trade show organized by the Consumer Technology Association (CTA), always held in January at Las Vegas Convention Center in Las Vegas (US). It hosts presentations of new products and technologies in the consumer electronics industry. ST-I had a private booth at CES, where different potential customers have been invited and got the possibility to discuss potential usage of x-Cube-AI.
Target/Audience	Consumer Electronic community.
Date and Place	January 8 th -11 th 2019, Las Vegas (US)
Number of	In 2019 edition it gathered 175K+ attendees, with 45K+ exhibiting companies.

attendees	
Name of the event	HiPEAC conference 2019
Who attended	UNICA, UNISS, IBM and IRIDA
Description	ALOHA project was present at HiPEAC (European Network on High Performance and Embedded Architecture and Compilation) 2019 in Valencia with a dedicated booth where all visitors had the opportunity to discuss with project representatives ALOHA's plans and/or results achieved so far. The booth was supported by a poster and a demo. The booth was attended by a project representative (UNICA, UNISS, IBM, IRIDA) during all the exhibition opening hours.
Target/Audience	Industrial and scientific stakeholders.
Date and Place	January 21-22, 2019, Valencia, Spain.
Number of attendees	More than 1000 participants in total.
Name of the event	IBM Think! 2019
Who attended	IBM
Description	The premier industry conference for today's leading-edge technologies, and for the people who create and use them. With over 30,000 attendants, IBM Think established itself as a "must attend" meeting for both executives and technical professionals.
Target/Audience	IBM representatives and clients all over the world, both executives and technical professionals.
Date and Place	February 12-15 2019, San Francisco, USA
Number of attendees	>30,000
Name of the event	Embedded World 2019
Who attended	ST-I
Description	Embedded World is the leading international fair for embedded systems. Every year at Embedded World the latest innovations in the embedded sector (ranging

	from construction elements through modules and full systems, operating systems, hard and software to services) are presented. ST-I participated with a booth where x-Cube-AI was shown with a demo.
Target/Audience	Industrial Embedded System researcher and practitioners.
Date and Place	26 th - 28 th February 2019, Nuremberg, Germany
Number of attendees	In 2019 Embedded World gathered together more than 32,000 trade visitors and approximately 2,200 conference participants from 77 countries that had the opportunity to meet with more than 1,100 exhibitors from 52 countries that exposed.
Name of the event	Computing Frontiers 2019
Who attended	UNICA and UNISS
Description	ALOHA project was present at Computing Frontiers 2019. This year CF hosted two industrial sessions and one session on AI and CPS related EU projects. ALOHA achievements and toolchain has been presented in the EU project session and during the poster session. Moreover, being a sponsor of the conference, ALOHA materials have been distributed to all the participants. The conference has been organized by UNISS and attended also by UNICA.
Target/Audience	Industrial and scientific stakeholders.
Date and Place	April 30 – May 2, 2019, Alghero, Italy.
Number of attendees	More than 70 participants in total.
Name of the event	Driving the Digital Transformation of manufacturing
Who attended	REPLY
Description	This networking event is focused on the three main pillars that are enabling the Industry 4.0 Digital Transformation, namely Industrial IoT, Industrial Analytics and Artificial Intelligence. Reply took the opportunity to build connections with leading European organizations in the EIT Digital ecosystem and introduce ALOHA innovation potential.
Target/Audience	Industrial and scientific stakeholders.
Date and Place	19 June 2019 Milan, Italy.

Number of attendees	About 100
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5 Conclusions

This document represents the first report of the Exploitation activities carried out within the ALOHA project in the first 18 months, in which all the planned activity has been completed. In Table 6, we summarize the number of all the quantifiable exploitation activities achieved since the beginning of the project.

Table 6 - Quick summary of the overall exploitation activities.

Exploitation achievements	Number
Key Exploitable Result completed and already released	2
Development of new Product/Service	7
Organization of a seminar/tutorial by ALOHA industrial partners	6
Organization of a workshop by ALOHA academic and RTO partners	5
Invited Talk in an event involving Industry community	1
Participation in a Fair, Booth and other events	12
Assigned theses	7
Lab assignments in specific MSc-level courses	2
Follow-up project proposal	1

All these activities are in line with what we planned in D6.1 and no deviations have to be reported.

As a final consideration please note that 3 different Key Performance Indicators (KPI) were listed in D6.1 as relevant for the exploitation activities, namely:

1. **KPI5** - Integration of the project results in at least seven industrial products and development flows.
2. **KPI6** - Number of downloads of the open source ALOHA software components.
3. **KPI7** - Involvement of 10-30 external industrial users.

Details related to KPI7 have been reported in *D7.5 - Communication and Dissemination Report*, where we discussed the current composition of ALOHA user community in Section 5.2. At the moment, we have 26 registered members, part of which industrials coming from companies such as Intel, Abatec, and Atos, and we have planned concrete actions to extend this community. Therefore, we expect to easily meet the planned KPI. With respect to KPI5 and KPI6, since we released 2 exploitable results, it is extremely early to make any statistic/conclusion, but we can say that we are monitoring them and that so far everything is as expected according to our timeline. Regarding in particular the KPI5, all the industrial partners foresee the integration of the ALOHA results or part of them into future versions of their products or services. Even if one of the target products from CA is not considered anymore, we consider the KPI5 as a feasible target.

For the next period, the ALOHA consortium has identified a set of future exploitation activities, which are reported in detail in the deliverable 6.2 Exploitation Plan - First Update (M18).