TRANSPARENT APPLICATION DEPLOYMENT IN A SECURE, ACCELERATED AND COGNITIVE CLOUD CONTINUUM

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Abstract: The deliverable presents the final version of project dissemination materials. Launched in February 2021, the SERRANO project website (https://ict-serrano.eu) has been meticulously populated with relevant information about the SERRANO project. In addition, diverse dissemination channels have been established, including active social media accounts and a suite of dissemination materials such as a project factsheet, presentations, promotional videos, newsletters, and demonstration videos. These resources, along with the dissemination plan and activities whose final version is described in deliverable D7.11 (M36), collectively contribute to the comprehensive and effective dissemination of the SERRANO project.

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Abbreviations

BPaaS	Business Processes as a Service
CDSSaaS	Cognitive Distributed Secure Storage as a Service
D	Deliverable
EC	European Commission
ESAaaS	Extreme Scale Analytics as a Service
HPC	High-Performance Computing
IaaS	Infrastructure as a Service
ICCS	Institute of Communication and Computer Systems
PaaS	Platform as a Service
SaaS	Software as a Service

1 Executive Summary

This deliverable describes the final version of the SERRANO project dissemination materials created for advertising the project outcomes and advances. For completeness, the deliverable is built upon the initial report on dissemination material from deliverable D7.1 (M6) and the intermediate report from deliverable D7.6 (M18).

The website (https://ict-serrano.eu) constitutes the primary online tool for disseminating all relevant outcomes of the project. The website also presents additional general information, news, and events regarding the SERRANO project and provides public deliverables and project publications.

The website went online in February 2021 according to the proposed timeline schedule. There are seven main pages, namely: “Home”, “Consortium”, “Vision”, “Objectives”, “Work Packages”, “Use Cases”, “Public Deliverables”, “Publications”, “Communication Material”, “News” and “Contact”. The website has been designed so that it is easy for every user to find all the necessary information effectively and accurately.

In addition to the website, the project established other dissemination channels like social media accounts to enhance the project's visibility and advertise the project's outcomes. Complementary, we have created a dedicated communication media kit that includes the project factsheet, which summarizes the main takeaway of the project concept, a project presentation, a promotional video, a roll-up banner, and nine newsletters to keep the audience and research community up to date with the project advances.

2 Introduction

2.1 Purpose of this document

The objective of this deliverable is to present the SERRANO dissemination material that has been produced to advertise the SERRANO project. The package includes the website and the social media accounts used by SERRANO partners for project dissemination and communication activities. Moreover, the final version of the produced dissemination material contains the SERRANO project factsheet, a high-level project presentation, a roll-up banner, a promotional video, and nine newsletters. In addition, the dissemination package includes the public deliverables, the project publications in peer-reviewed international journals and conferences, and a set of videos that demonstrate the project's achievements.

2.2 Document structure

The present deliverable contains the following chapters:

- Executive Summary
- Introduction
- SERRANO Website
- Social Media Accounts
- Promotional Video
- Newsletters
- Updated Factsheet
- Updated Project Presentation
- SERRANO Banner
- Demonstration Videos

2.3 Audience

This document is public.

3 SERRANO Website

The SERRANO website has been created and hosts all the basic information regarding the project and its partners; it can be reached at this address: https://ict-serrano.eu.

The project website acts as the primary communication channel between the project's partners and the public. As the project progressed, the site was updated regularly by the site administrator (ICCS) with new content to reflect the state of the project, maximize dissemination of the achieved results, and increase project awareness. The updated content included news, public documents and deliverables, publications, newsletters, and promotional videos. Moreover, ICCS will maintain the project website active for at least three years after the project ends, ensuring continuous promotion of project achievements.

The SERRANO website follows a neat design that provides a modern feel and easy access for its various pages. The key features include:

- an attractive, user-friendly, and professional design;
- easy access to the key project information (objectives, work packages, and use cases);
- a comprehensive presentation of the project consortium by using links to each partner's webpage;
- links to the project's social media pages;
- news and events pages to keep users up to date with the latest project developments;
- "Communication Material" to present useful information regarding the project;
- contact information;
- ability to update the website's content.

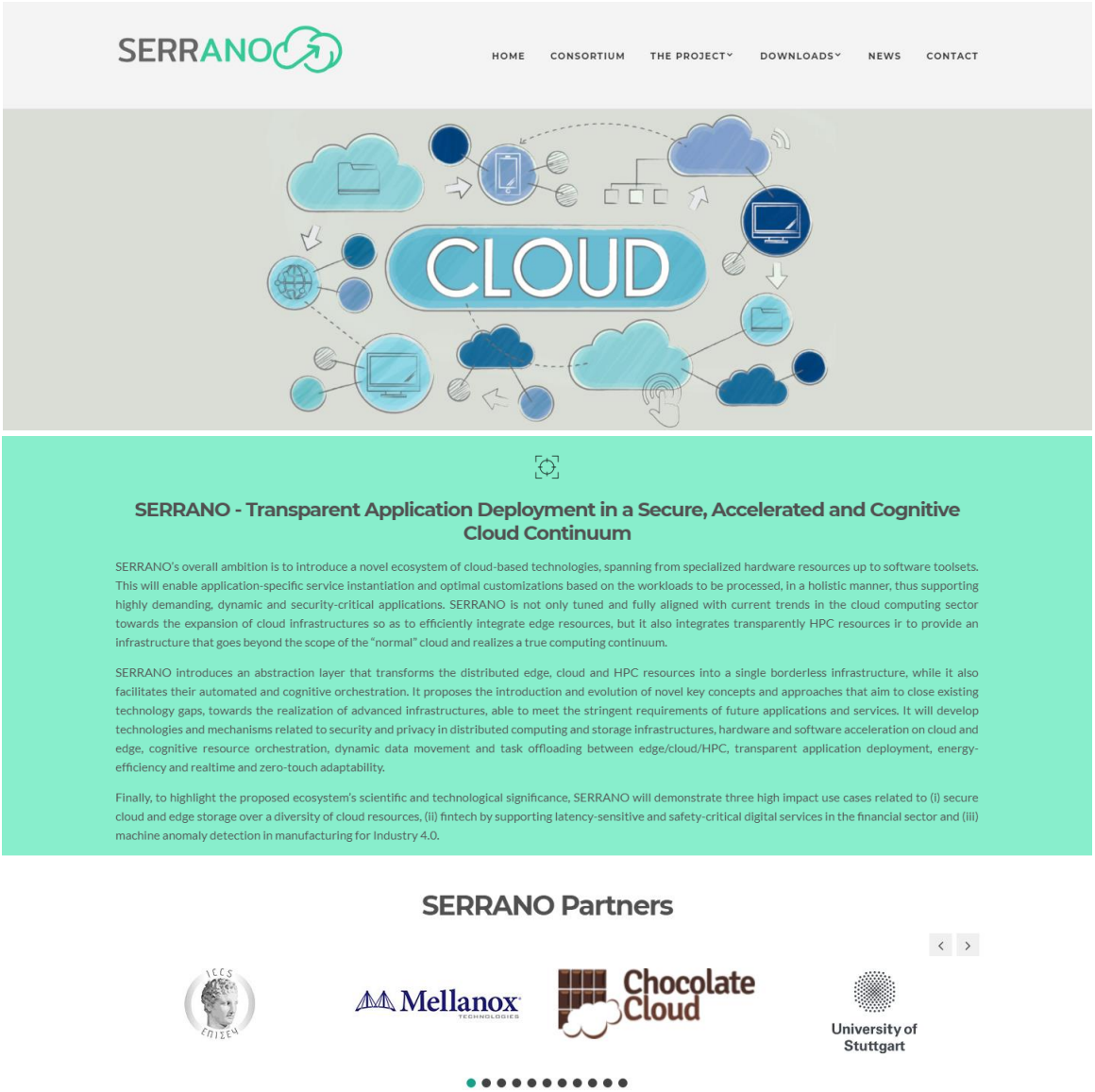
The structure of the SERRANO website is the following:

- Home
- Consortium
- The Project
    - Vision
    - Objectives
    - Work Packages
    - Use Cases
- Downloads
    - Public Deliverables
    - Publications
    - Communication Material
- News
- Contact

In what follows, we provide screenshots and a brief description of each page of the website.

Home Page

The SERRANO's portal home page (https://ict-serrano.eu) in Figure 1 briefly introduces the project, the consortium members and the latest news. The header and footer sections are the same for all the pages of the website and are always visible.



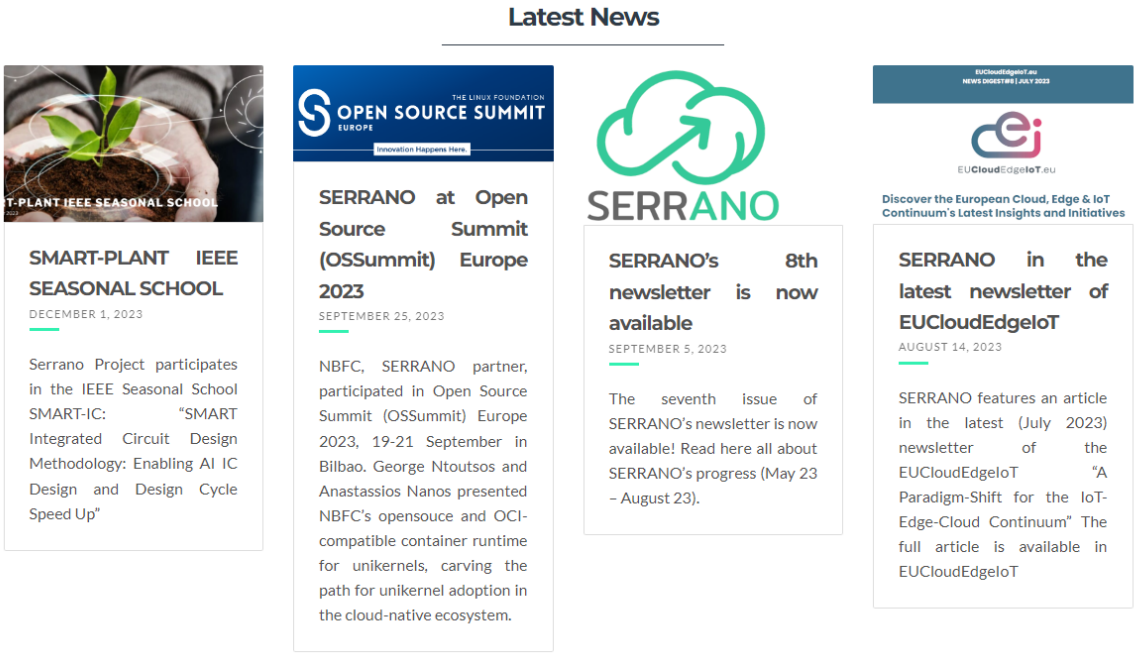


Figure 1: SERRANO Home Page

The header (Figure 2) consists of the SERRANO logo and the website menu, through which the users are able to navigate to the individual pages. The "Project" menu option includes the following four sub-sections: “Vision”, “Objectives”, “Work Packages” and “Use Cases”. The “Downloads” menu option includes the following three sub-sections: “Public Deliverables”, “Publications” and “Communication Material”. The footer (Figure 3) includes an acknowledgment to the European Union’s Horizon 2020 framework, the grant agreement number, and links to project’s social media accounts (e.g., Twitter, LinkedIn, YouTube).

Figure 2: SERRANO website header section

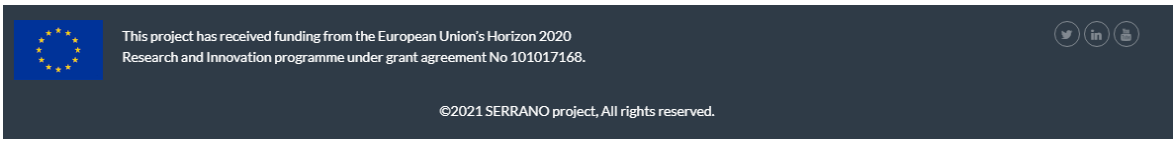


Figure 3: SERRANO website footer section

Consortium

The “Consortium” page (Figure 4) provides basic information about the project partners and links to their websites.

Figure 4: Website section “Consortium”

Vision

The "Vision" page (Figure 5) presents briefly the SERRANO concept and the overall vision of the project.

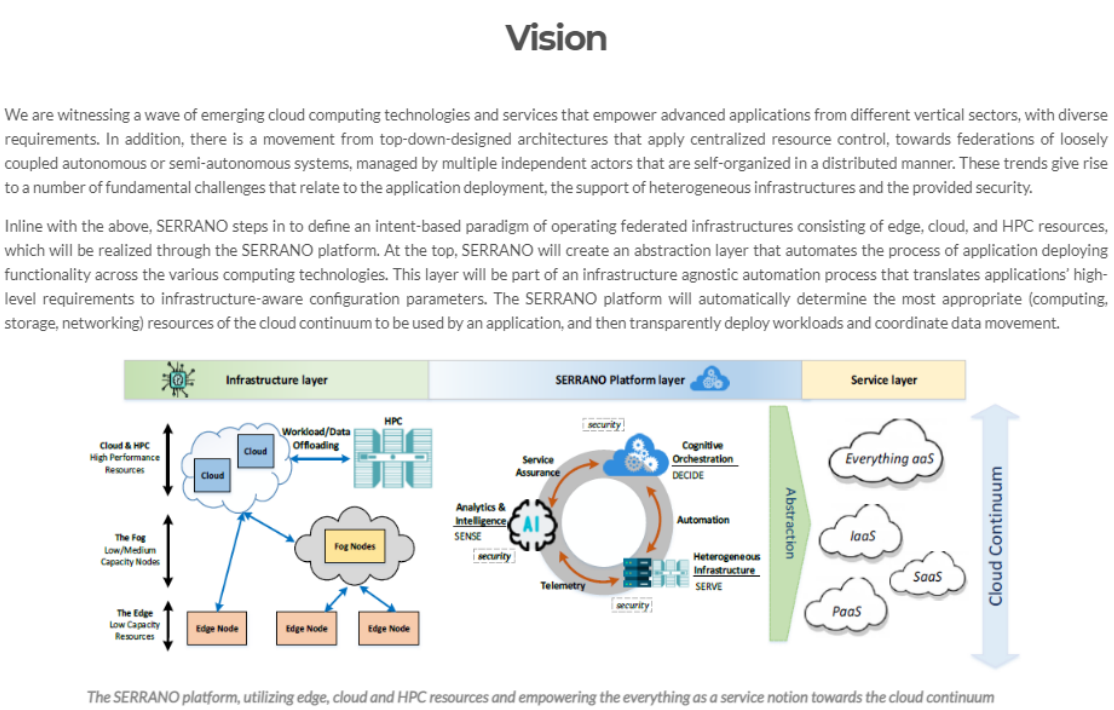
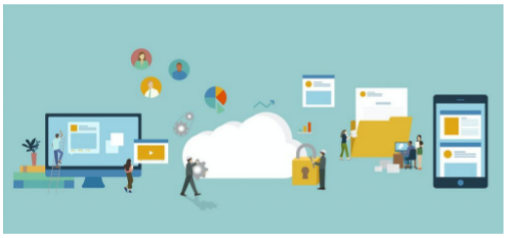


Figure 5: Website section "Vision"

Use Cases

The “Use Cases” section (Figure 6) presents an overview of the three SERRANO use cases and the critical limitations SERRANO is expected to address.

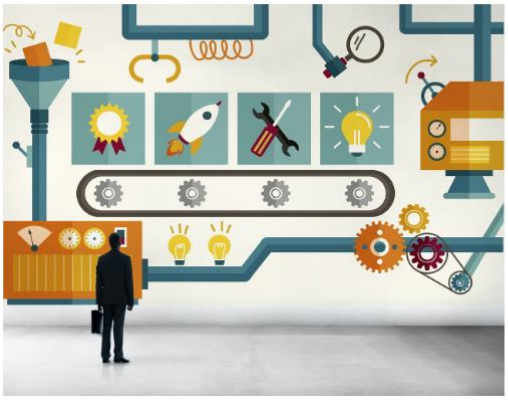


Use Case 1 – Secure Storage

This use case focuses on providing secure and high-performance storage and sharing of various data types at the edge of the network. In particular, SERRANO aims to break the typical trade-off between security and performance, by utilizing a combination of multiple edge locations and even multiple cloud computing and storage services/providers. Providing security and privacy guarantees for storing various types of data, e.g., IoT sensors, video, images, at the edge is critical for enabling the development of new applications, while ensuring compliance with the GDPR and other privacy regulations. Since this compliance typically comes at the cost of reduced performance or speed, there is a need for efficient mechanisms for secure storage that exploit the capabilities of both edge and cloud. The architecture consists of multi-cloud and multi-edge subsystems that will (i) deliver a more robust and secure platform, and (ii) use novel security and resource allocation techniques to manage data privacy for the stored and processed data. SERRANO considers a system model with multiple edge and remote clouds, aiming to tackle the challenges of managing: the heterogeneity of the QoS requirements from different applications, the limited resources of the edge clouds, and the policy restrictions from a multi-cloud system. In this way, a security-by-design solution for storage will be delivered.

Use Case 2 – High-performance Fintech Analysis

The management of investment personalized portfolios entails continuous monitoring and adjustment so that it has optimal return and risk balance. The markets and the portfolios are simulated for what if conditions. The result of these operations is trading orders that are subsequently executed. SERRANO's ability to determine automatically the optimal execution platform enables the intelligent and transparent deployment of computationally and data intensive applications into a diverse set of cloud and HPC platforms. This capability will enable unprecedented innovation in investment management (higher return and lower risk), peer-to-peer lending (credit scoring and lower interests), insurance (premium calculation) and banking (fraud detection) with the application of compute intensive AI and ML algorithms. SERRANO will address three important limitations for high-performance fintech analysis. First, the enhanced security will simplify the implementation of secure channels between processes that run on different clouds, decreasing its dependence on a single cloud platform. Second, the HPC access through the cloud would enable innovation in using compute intensive operations for portfolio and market analysis. Third, the transparent deployment across different cloud platforms will enable the seamlessly integration of private infrastructures with various public infrastructures in a federated cloud setting.



Use Case 3 – Machine Anomaly Detection in Manufacturing Environments

Companies that manufacture extremely expensive, high added-value parts (e.g. for the aerospace sector) are very demanding in terms of machine availability and quality assurance. Predictive maintenance, remaining lifetime assessment and diagnosis of critical machine elements are state-of-the-part practices. However, some of the utilized techniques require from the machine to stop, before performing the analysis. As a result, the various hardware components are idle most of the time, waiting for the analysis procedures to start, something that the manufacturing industries are keen to avoid. Another approach is to perform these analyses continuously, while the hardware equipment keeps running at 100% and the state of the various independent components, along with the overall status is continuously reported. However, the high-frequency and high-accuracy sensors used for data acquisition, generate high volumes data, which are difficult to process in real-time at the edge due to limited availability of resources. Introducing mechanisms that orchestrate optimally data and computational movement in the edge, cloud and HPC can overcome this obstacle. This is the role of the SERRANO platform in this UC, highlighting it as a key enabler for the fourth industrial revolution.

Figure 6: Website section “Use Cases”

Objectives and Work Packages

The first section (Figure 7) enumerates the project objectives, while the second one (Figure 8) presents a short description of the project Work Packages.

Figure 7: Website section "Objectives"

Figure 8: Website section "Work Packages"

Public Deliverables and Publications

The "Public Deliverables" and "Publications" sections contain information regarding the publications performed by the partners in the context of the SERRANO project. Moreover, the public deliverables are available through the respective section.

Publications

The list of the publications in scientific journals of the SERRANO project:

1. K. Balaskas, G. Zervakis, H. Amrouch, J. Henkel and K. Siozios, "Automated Design Approximation to Overcome Circuit Aging", IEEE Transactions on Circuits and Systems I: Regular Papers
2. K. Balaskas, F. Klemme, G. Zervakis, K. Siozios, H. Amrouch and J. Henkel, "Variability-Aware Approximate Circuit Synthesis via Genetic Optimization", IEEE Transactions on Circuits and Systems I: Regular Papers
3. A. Kokkinis, D. Diamantopoulos and K. Siozios, "Dynamic Optimization of On-Chip Memories for HLS Targeting Many-Accelerator Platforms," in IEEE Computer Architecture Letters, vol. 21, no. 2, pp. 41-44, 1 July-Dec. 2022, doi: 10.1109/LCA.2022.3190048.
4. D. Danopoulos, G. Zervakis, K. Siozios, D. Soudris and J. Henkel, "AdaPT: Fast Emulation of Approximate DNN Accelerators in PyTorch," in IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, vol. 42, no. 6, pp. 2074-2078, June 2023, doi: 10.1109/TCAD.2022.3212645.
5. I. Sartzetakis, E. Varvarigos, "Network Tomography with Partial Topology Knowledge and Dynamic Routing" ,Journal of Network and Systems Management, Vol. 31, 73 (2023). ttps://doi.org/10.1007/s10922-023-09763-y
6. L. Cerdà-Alabern, G. Iuhasz, G, Gemmi, "Anomaly detection for fault detection in wireless community networks using machine learning", Computer Communications, Volume 202, 2023, https://doi.org/10.1016/j.comcom.2023.02.019.
7. K. Kontodimas, P. Soumplis, A. Kretsis, P. Kokkinos, M. Fehér, D. Lucani, E. Varvarigos, "Secure Distributed Storage Orchestration on Heterogeneous Cloud-Edge Infrastructures", IEEE Transactions on Cloud Computing, June 2023, doi: 10.1109/TCC.2023.3287653
8. I. Sartzetakis, E. Varvarigos, "Edge/Cloud Infinite-time Horizon Resource Allocation for Distributed Machine Learning and General Tasks", IEEE Transactions on Network and Service Management, September 2023
9. K. Balaskas, A. Karatzas, C. Sad, K. Siozios, I. Anagnostopoulos, G. Zervakis, J. Henkel, "Hardware-Aware DNN Compression via Diverse Pruning and Mixed-Precision Quantization", IEEE Transactions on Emerging Topics in Computing

The list of the publications in conferences of the SERRANO project:

1. A. Ferikoglou, I. Oroutzoglou, A. Kokkinis, D. Danopoulos, D. Masouros, E. Chondrogiannis, A. Fernandez Gomez, A. Kretsis, P. Kokkinos, E. Varvarigos and K. Siozios, "Towards efficient HW acceleration in edge-cloud infrastructures: The SERRANO approach", International Conference on Embedded Computer Systems: Architectures, Modeling and Simulation (SAMOS), 2021
2. A. Kokkinis, A. Ferikoglou, D. Danopoulos, D. Masouros and K. Siozios, "Leveraging HW approximation for exploiting performance-energy trade-offs within the edge-cloud computing continuum", Workshop on Virtualization in High-Performance Cloud Computing (VHPC), 2021
3. D. Khabi, "SERRANO hardware system simulator in HPC, Edge and Cloud environments", Workshop on Intelligent operations, security, and acceleration for edge computing (MeditCom), 2021
4. B. Pismenny, J.J. Olmos, Y. Zack, L. Liss, A. Dömeke, C. Stan, C. Garcia, I. Monroy, P. Kokkinos, A. Kretsis and E. Varvarigos, "Securitization of cloud, edge and IoT communications through hardware accelerations/offloadings", Workshop on Intelligent operations, security, and acceleration for edge computing (MeditCom), 2021
5. A. Kretsis, P. Kokkinos, P. Soumplis, J.J. Olmos, M. Feher, M. Sipos, D. Lucani, D. Khabi, D. Masouros, K. Siozios, P. Bourgos, S. Tsekeridou, F. Zyulkyarov, E. Karanastasis, E. Chrondrogiannis, V. Andronikou, A. Gomez, S. Panica, G. Luhasz, A. Nanos, C. Chalios and E. Varvarigos, "SERRANO: Transparent Application Deployment in a Secure, Accelerated and Cognitive Cloud Continuum", Workshop on Intelligent operations, security, and acceleration for edge computing (MeditCom), 2021
6. K. Kontodimas, P. Soumplis, A. Kretsis, P. Kokkinos and E. Varvarigos, "Secured Distributed Storage Resource Allocation on Cloud-Edge Infrastructures", IEEE International Conference on Cloud Networking, 2021 ***(Best paper award)***
7. A. Spataru, G. Iuhasz and S. Panica, "TUFA: A TOSCA extension for the specification of accelerator-aware applications in the Cloud Continuum", Workshop Big Data Processing on the Computing Continuum (COMPSAC 2022)
8. P. Kokkinos, D. Margaris and D. Spiliotopoulos, "A Quality of Experience Illustrator User Interface for Cloud Provider Recommendations", International Conference on Human-Computer Interaction (HCII 2022)
9. I. Sartzetakis, P. Soumplis, P. Pantazopoulos, K. V. Katsaros, V. Sourlas, and E. Varvarigos, "Resource Allocation for Distributed Machine Learning at the Edge-Cloud Continuum", IEEE International Conference on Communications (ICC 2022)
10. I. Oroutzoglou, A. Kokkinis, A.Ferikoglou, D. Danopoulos, D. Masouros and K. Siozios, "Optimizing Savitzky-Golay Filter on GPU and FPGA Accelerators for Financial Applications", IEEE International Conference on Modern Circuits and Systems Technologies (MOCAST 2022)
11. I. Sartzetakis and E. Varvarigos, "Machine Learning Network Tomography with partial topology knowledge and dynamic routing", IEEE Global Communications Conference (GLOBECOM 2022)
12. P. Kokkinos, "Towards the Realization of Converged Cloud, Edge and Networking Infrastructures in Smart MegaCities", 27th IEEE Symposium on Computers and Communications (ISCC 2022)
13. A. Kokkinis, D. Diamantopoulos, K. Siozios, "Dynamic Heap Management in High-Level Synthesis for Many-Accelerator Architectures", IEEE 32nd International Conference on Field-Programmable Logic and Applications (FPL 2022)
14. A. Kokkinis, A. Ferikoglou, I. Oroutzoglou, D. Danopoulos, D. Masouros, and K. Siozios, "HW/SW Acceleration of Multiple Workloads Within the SERRANO's Computing Continuum", International Conference on Embedded Computer Systems: Architectures, Modeling and Simulation (SAMOS 2022)
15. A. Kokkinis, G. Zervakis, K. Siozios, M. B. Tahoori and J. Henkel, "Hardware-Aware Automated Neural Minimization for Printed Multilayer Perceptrons", Design, Automation & Test in Europe Conference & Exhibition (DATE 2023)
16. A. Ferikoglou, A. Kokkinis, D. Danopoulos, I. Oroutzoglou, A. Nanos, S. Karanastasis, M. Sipos, J. Ghotbi, J.J. Vegas-Olmos, D. Masouros, K. Siozios, "The SERRANO platform: Stepping towards seamless application development & deployment in the heterogeneous edge-cloud continuum", Design, Automation & Test in Europe Conference & Exhibition (DATE 2023)
17. G. Iuhasz, S. Panica, A. Duma, "Cycle Detection and Clustering for Cyber Physical Systems", International Conference on Advanced Information Networking and Applications (AINA-2023)
18. A. Kokkinis, A. Nanos, K. Siozios, "Enabling An Isolated And Energy-Aware Deployment of Computationally Intensive Kernels on Multi-Tenant Environments", International Conference on Embedded Computer Systems: Architectures, Modeling and Simulation (SAMOS 2023)
19. A.Nanos, A. Kretsis, C. Mainas, G. Ntouskos, A. Ferikoglou, D. Danopoulos, A. Kokkinis, D. Masouros, K. Siozios, P. Soumplis, P. Kokkinos, J.J. Vegas Olmos, and E. Varvarigos, "Hardware-Accelerated FaaS for the Edge-Cloud Continuum", Cloud-Edge Continnum Workshop (CEC23)
20. P. Soumplis, G, Kontos, A. Kretsis, P. Kokkinos, A. Nanos, and E. Varvarigos, "Security-Aware Resource Allocation in the Edge-Cloud Continuum", IEEE 12th International Conference on Cloud Networking (CloudNet 2023)
21. E. Chondrogiannis, E. Karanastasis, V. Andronikou, A. Spătaru, A. Nanos, A. Kretsis, P.Kokkinos, "Intent-based AI-enhanced Service Orchestration for application deployment and execution in the Cloud Continuum", 10th European Conference On Service-Oriented And Cloud Computing (ESOCC 2023)

Figure 9: SERRANO publications

Public Deliverables

WP2 "Requirements and System Design"

D2.1 – State of-the-art analysis report (M6)
D2.2 – SERRANO use cases, platform requirements, and KPIs analysis (M6)
D2.3 – SERRANO architecture (M9)
D2.4 – Final version of SERRANO use cases, platform requirements, and KPIs analysis (M16)
D2.5 – Final version of SERRANO architecture (M18)

WP3 "Hardware and Software Platforms for Enhanced Security"

D3.1 – Accelerated encrypted storage architecture (M15)
D3.2 – Secure cloud storage system (M15)
D3.3 – Trust and isolated execution on untrusted physical tenders (M15)

D3.4 – Final release of SERRANO Secure Infrastructure Layer (M30) **

WP4 "Cloud and Edge Acceleration"

D4.1 – HW/SW IPs for workload acceleration in disaggregated DCs (M15)
D4.2 – Performance maximization under maximum affordable error for the HW and SW IPs (M15)
D4.3 – Framework for seamless integration of heterogeneous workload-aware performance improvement (M15)

D4.4 – Final Release of the SERRANO Cloud and Edge Acceleration Platforms and Tools (M30) **

WP5 "Intelligent Service and Resource Orchestration"

D5.1 – Abstraction models and intelligent service orchestration (M15)
D5.2 – Algorithmic framework, performance, and power models (M15)
D5.3 – Resource orchestration, telemetry, and lightweight virtualization mechanisms (M15)

D5.4 – Intelligent service and resource orchestration mechanisms (M31) **

WP6 "Platform Integration and Testing, Use Cases Development and Evaluation"

D6.3 – The SERRANO integrated platform (M18)

D6.4 – Business, end user and technical evaluation (M20) **

WP7 "Business Modelling, Dissemination, Exploitation and Standardization"

D7.1 – Project dissemination material and updates (M6)
D7.5 – Report on standardization activities (M18)
D7.6 – Intermediate project dissemination material and updates (M18)

** This Deliverable is pending to be approved by the European Commission

Figure 10: SERRANO public deliverables

Communication Material

The "Communication Material" section (Figure 11) provides easy access to dissemination and communication content. It includes all public dissemination documents. Moreover, the users can also navigate to the project's promotional and demonstration videos and the available newsletters. New material was constantly added as the project progressed.

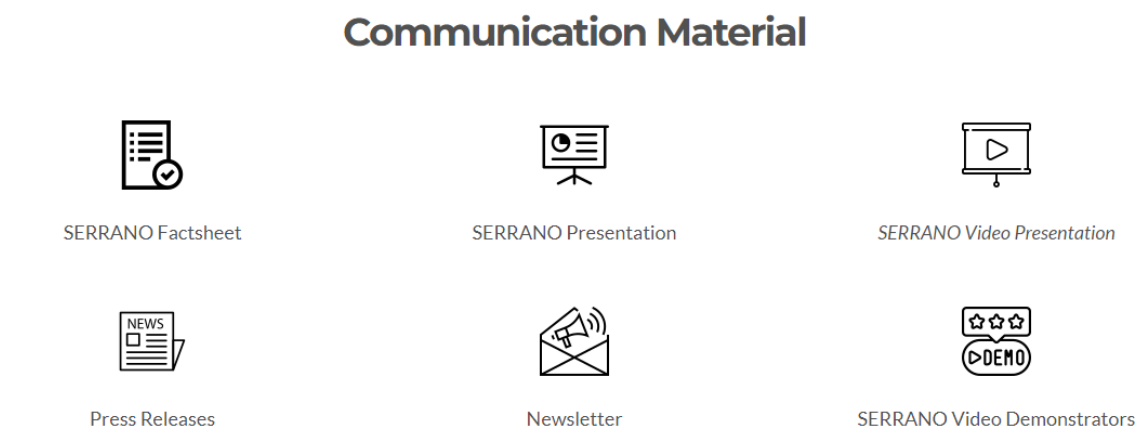


Figure 11: Website section "Communication Material"

Newsletters

The "Newsletters" section (Figure 12), accessible through the "Communication Material" section, lists the available Newsletters for download and enables users to subscribe through email to project newsletters.

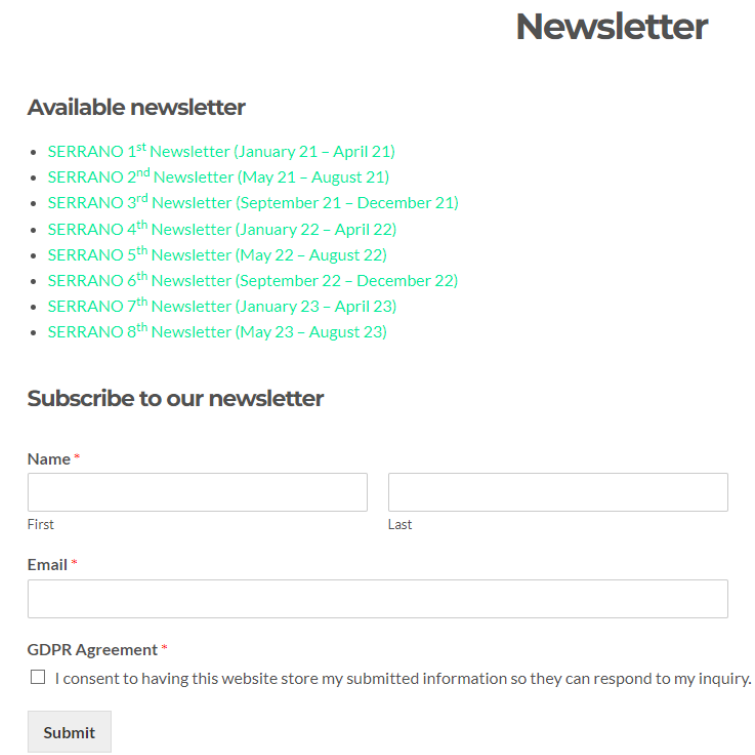


Figure 12: Website section "Newsletters"

News

The "News" section (Figure 13) includes news relevant to the project in the form of short, concise headings with additional links where necessary.

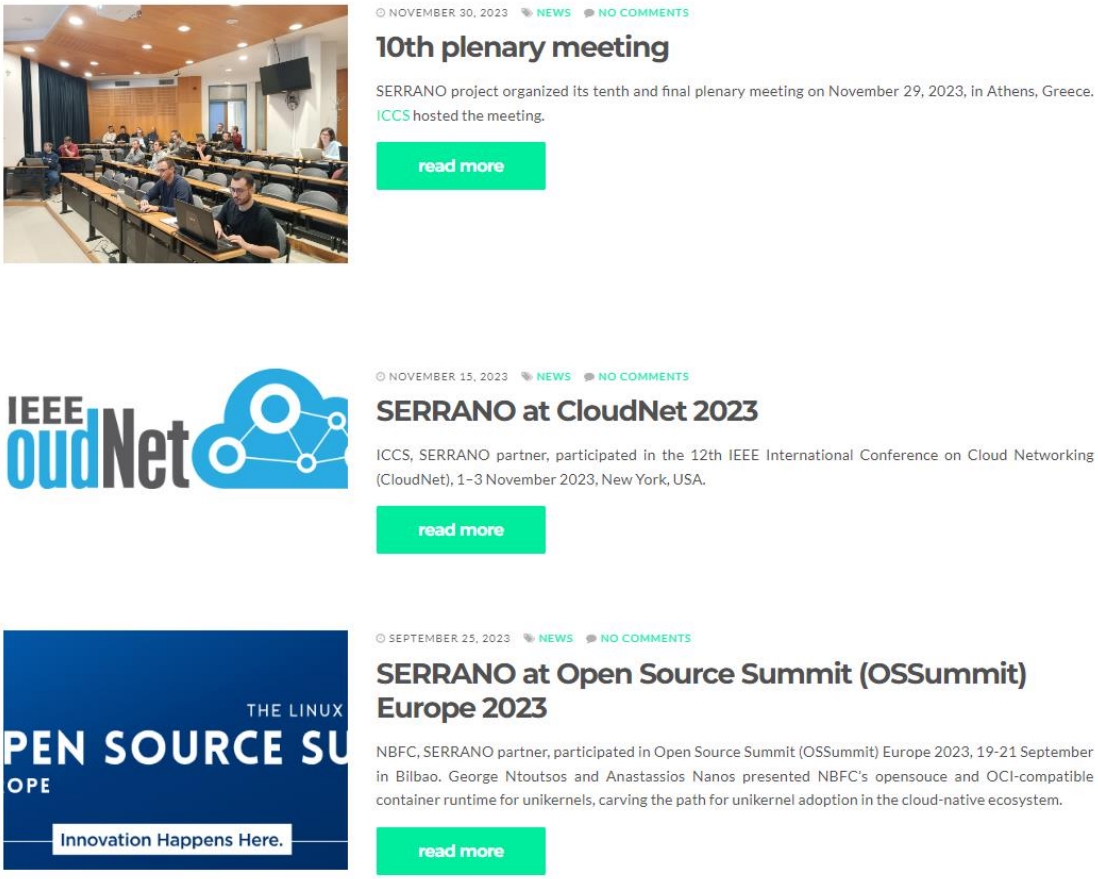


Figure 13: Website section "News"

Contact

The "Contact" section (Figure 14) provides information (email, phone and address) for contacting the SERRANO project coordinator. An e-mail message application is also available through which it is possible to communicate directly with the coordinator.

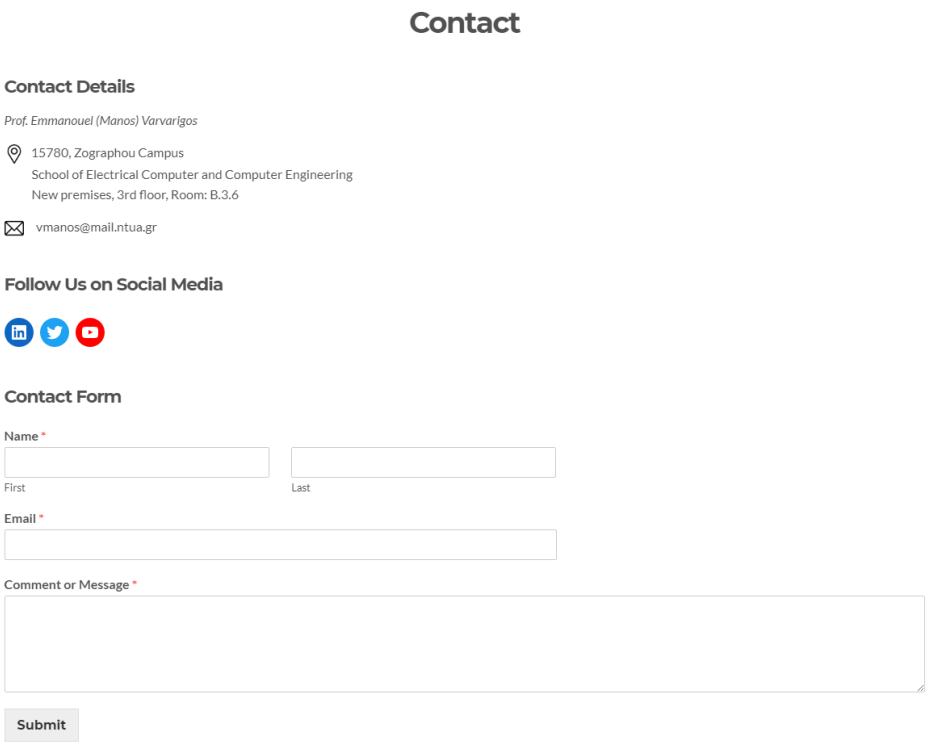


Figure 14: Website section "Contact"

4 Social Media Accounts

SERRANO has strategically set up accounts on diverse social networking platforms, including Twitter, LinkedIn, ResearchGate, and YouTube, enhancing its dissemination efforts. ICCS created and managed these social media accounts and groups. Committing to sustained engagement, the project's social media accounts will remain active for at least six months after the project ends, ensuring continuous promotion of noteworthy project achievements, such as accepted publications and presentations.

Twitter

SERRANO Twitter account (Figure 15) can be found at the following address:

- https://twitter.com/ProjectSerrano

Figure 15: SERRANO twitter account home page

The project follows 110 other accounts (Figure 16), while it has 101 followers (Figure 17), including other EU projects.

Figure 16: SERRANO follows many H2020 projects and respective initiatives

Figure 17: SERRANO followers

LinkedIn

The LinkedIn account of SERRANO (Figure 18) can be found at the following link:

- https://www.linkedin.com/company/serrano-project

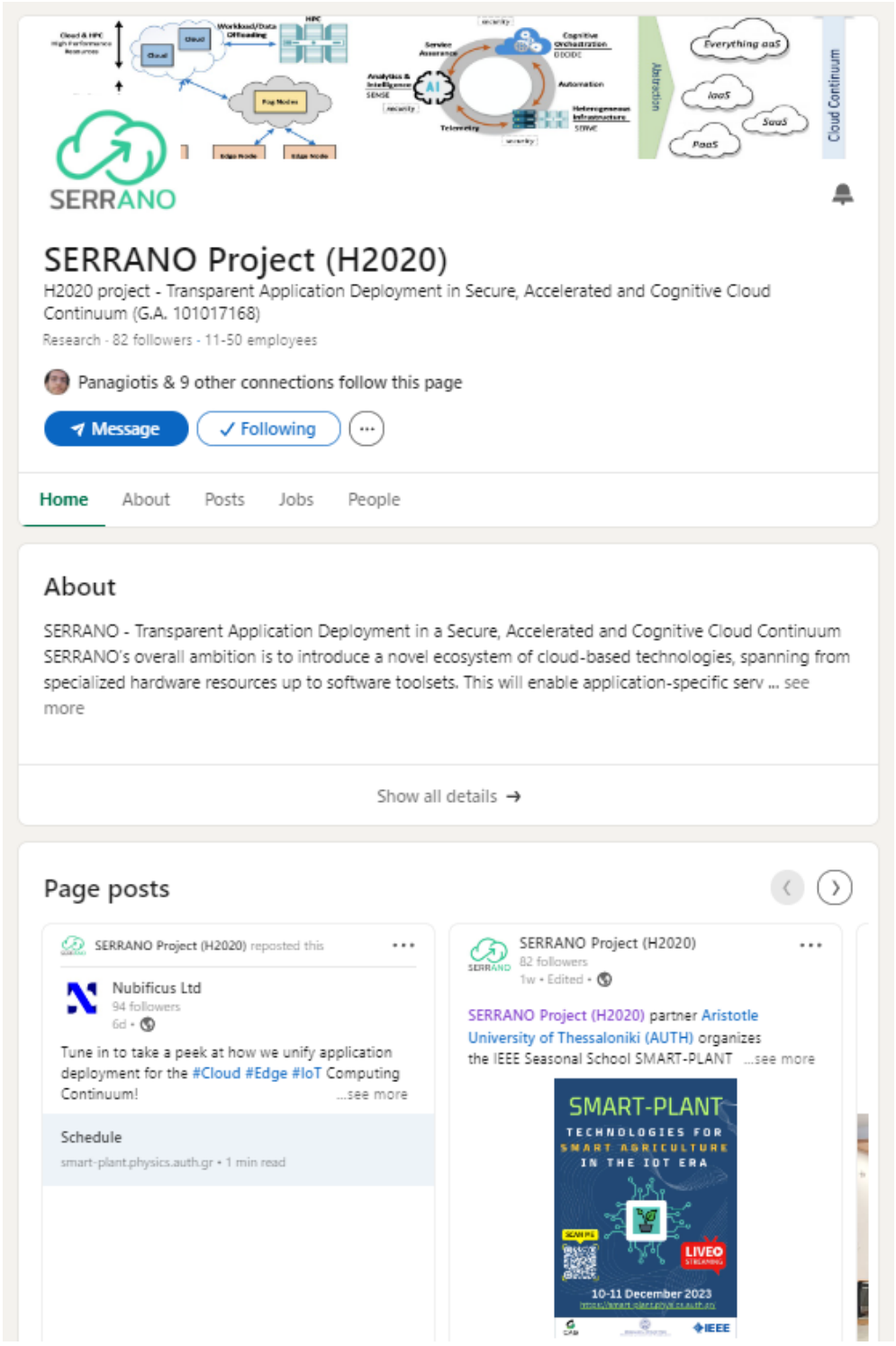


Figure 18: SERRANO LinkedIn profile

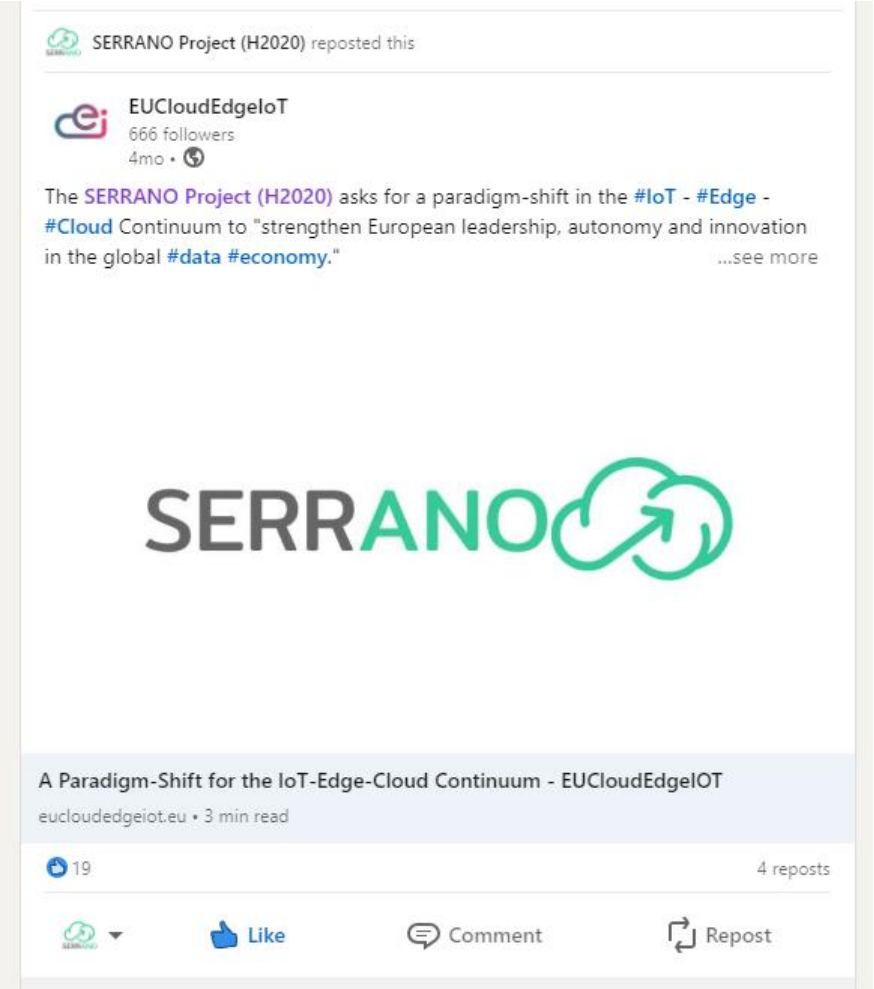


Figure 19: Dissemination of SERRANO position article in EuCloudEdgeIoT[1] initiative through SERRANO LinkedIn page

YouTube

The Official Video Channel on YouTube of SERRANO (Figure 20) can be found at the following address:

- https://www.youtube.com/channel/UC76DXLVZQauLxyHpGW9qIuw

[1] EUCloudEdgeIoT initiative: https://eucloudedgeiot.eu

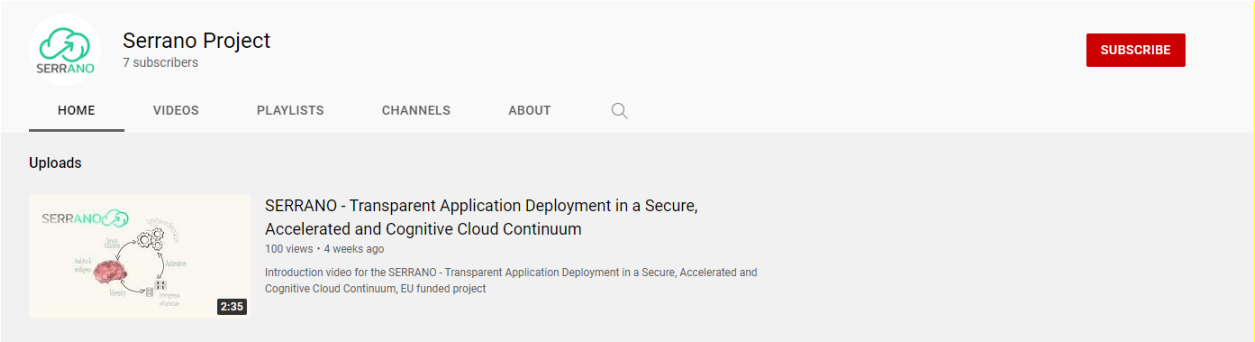


Figure 20: SERRANO YouTube channel home page

5 Promotional Video

The consortium has also produced one promotional video targeting the general public. In this video, the fundamental concepts and targets of the project are presented, and having in mind the nature of this video, the consortium has uploaded it on the YouTube platform in order to gain the maximum possible visibility (link: https://www.youtube.com/watch?v=ae35MfIWsGY).

The video can be found under the title "SERRANO - Transparent Application Deployment in a Secure, Accelerated and Cognitive Cloud Continuum" as seen in the picture below. The video link has also been added to the project's website.

Figure 21: SERRANO promotional video in YouTube

5.1 Video Presentation

The video starts with the presentation of the ever-evolving cloud landscape.

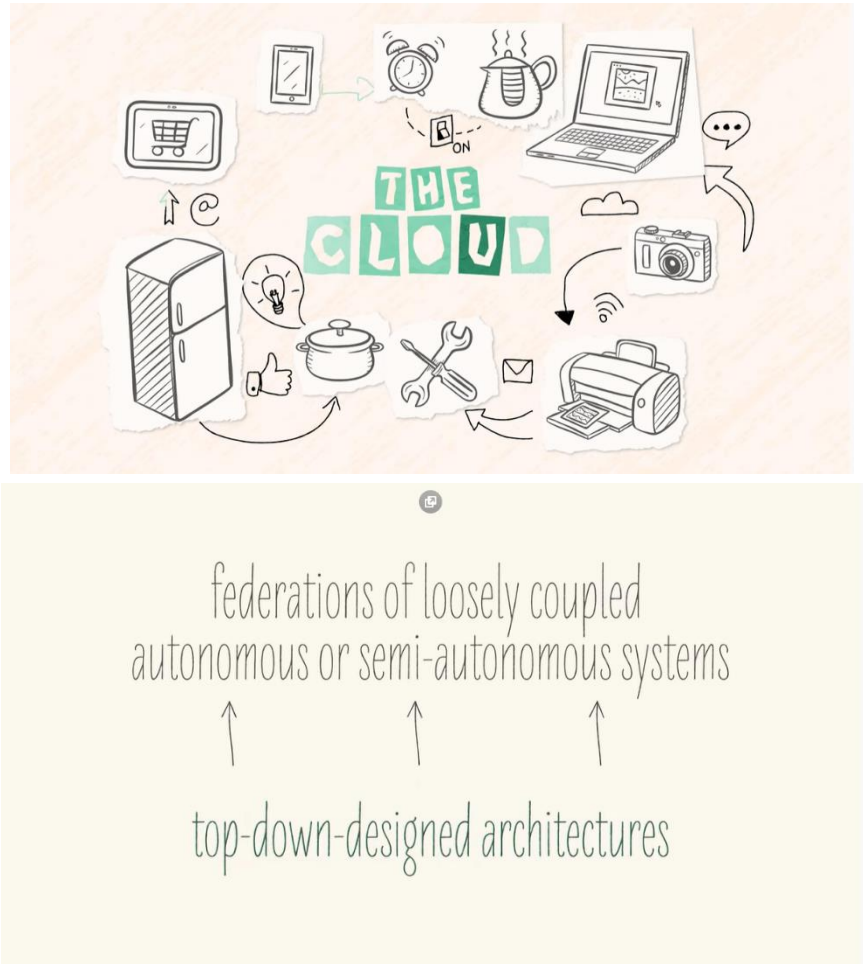
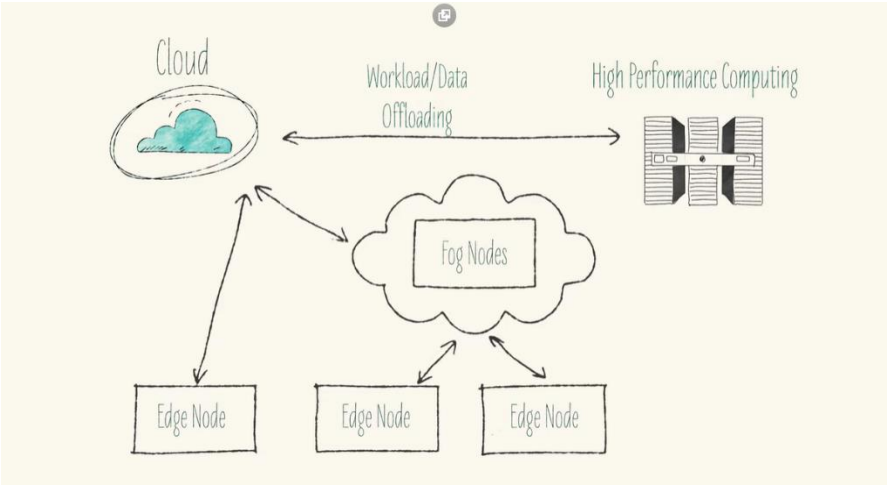


Figure 22: The evolving cloud landscape

Next, it describes (Figure 23) the SERRANO vision that aims to introduce a cognitive abstraction layer that transforms the distributed edge, cloud, and HPC resources into a single borderless infrastructure. It also highlights (Figure 24) the key technologies and mechanisms that SERRANO will develop.



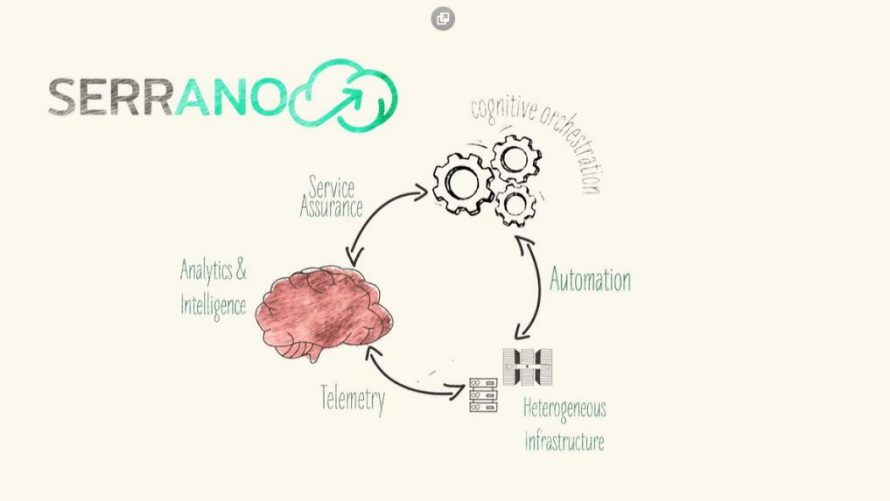


Figure 23: Presentation of the SERRANO vision

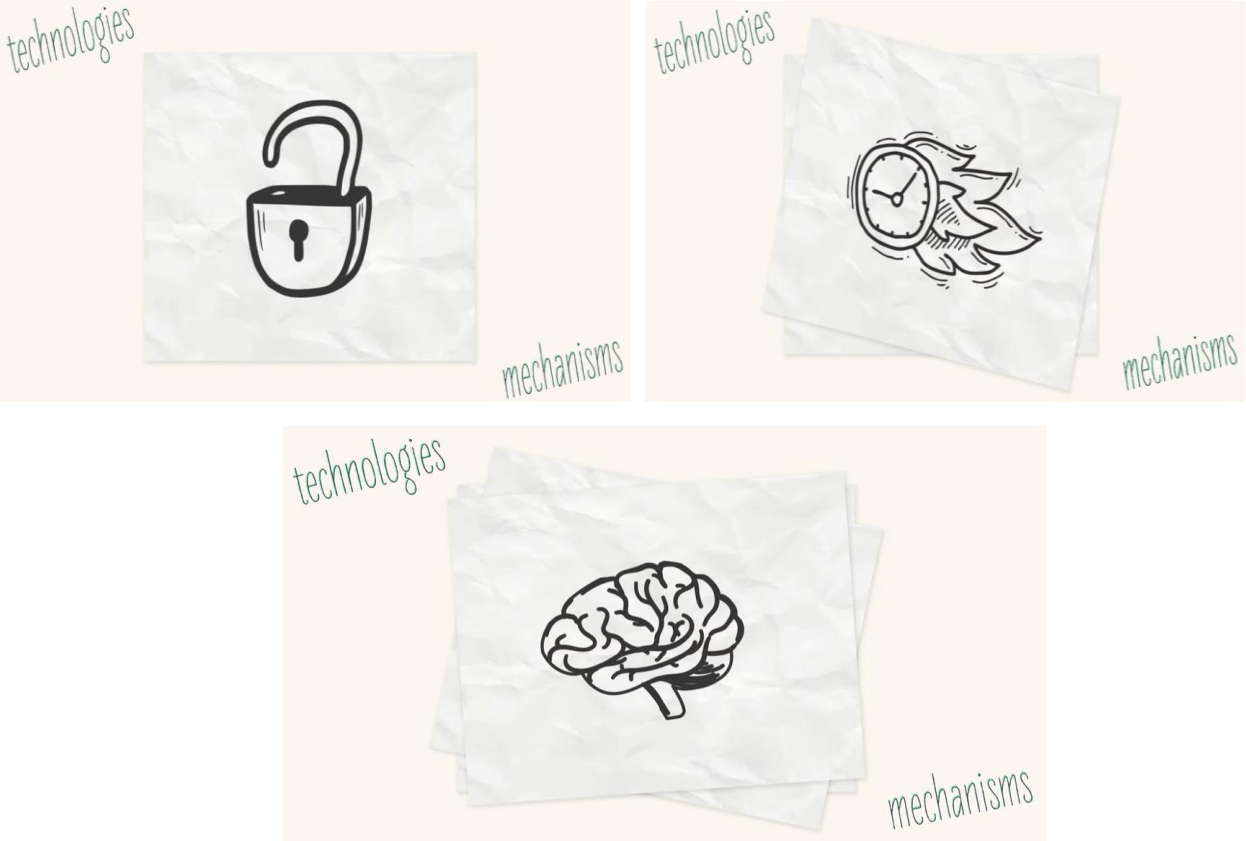


Figure 24: Presentation of the key technologies that SERRANO project develops

It continues with the presentation of the three project use cases.

Figure 25: Introduction of the project use cases

Finally, the project consortium is introduced.

Figure 26: Project consortium presentation

5.2 Video Narration Script

The video narration script is attached below:

We are witnessing a wave of emerging cloud computing technologies and services that empower advanced applications.

In addition, there is a movement from top-down-designed architectures towards federations of loosely coupled autonomous or semi-autonomous systems.

SERRANO is not only tuned and fully aligned with current trends in the cloud computing sector toward the expansion of cloud infrastructures so as to efficiently integrate edge resources, but it also integrates transparently HPC resources to provide an infrastructure that goes beyond the scope of the "normal" cloud and realizes a true computing continuum.

SERRANO introduces an abstraction layer that transforms the distributed edge, cloud, and HPC resources into a single borderless infrastructure while it also facilitates their automated and cognitive orchestration.

SERRANO will develop technologies and mechanisms related to:

- *security and privacy in distributed computing and storage infrastructures*
- *hardware and software acceleration on cloud and edge*
- *cognitive resource orchestration*
- *transparent application deployment*
- *energy-efficiency and autonomous adaptability*

Finally, SERRANO will demonstrate three high impact use cases related to:

- *secure cloud and edge storage over a diversity of cloud resources*
- *fintech by supporting latency-sensitive and safety-critical digital services in the financial sector*
- *and machine anomaly detection in manufacturing*

6 Newsletters

Throughout the entire project duration, SERRANO has distributed nine newsletters across multiple mailing lists. Adhering to the established dissemination plan, the project consistently published a newsletter approximately every four months. The SERRANO newsletters are also conveniently accessible on the official project website (https://ict-serrano.eu/newsletters/). These newsletters are detailing the project's progress and accomplished achievements.

SERRANO 1st Newsletter (January 21 – April 21)

SERRANO EU Project

1st Newsletter (Jan '21 – Apr '21)

SERRANO

WE STARTED

On 28 January 2021, EU ICT-40-2020 SERRANO Project (H2020 GA No 101017168): Transparent Application Deployment in a Secure, Accelerated and Cognitive Cloud Continuum, kicked-off with the participation of 11 partners.

Consortium partners include: ICCC/NTUA (Cooridnator), MELLANOX/ NVIDA, Chocolate Cloud, Universitaet Stuttgart, Aristotelio Panepistimio Thessalonikis, Intrasoft, Inbestme, Innovation-Acts, IDEKO, Universitatea de Vest din Timişoara and Nubificus.

SERRANO will investigate the transparent deployment of applications in a secure and accelerated infrastructure of edge, cloud and HPC resources, based on FPGAs, GPUs, Virtual Platforms and Smart NICs, while facilitating their automated and cognitive orchestration.

The 2nd plenary meeting of the SERRANO Project took place on the 12th of April 2021,. The meeting offered a great opportunity for collaboration among partners, presenting the progress achieved and discussing the next steps.

at a glance

Project Title: Transparent Application Deployment in a Secure, Accelerated and Cognitive Cloud Continuum

Grant Agreement no: 101017168

Topic: ICT-40-2020 - Cloud Computing: towards a smart cloud computing continuum

Duration: 01/01/2021 – 31/12/2023 (36 months)

EC Contribution: 4.343.180,00 €

Project Coordinator: Prof. Manos Varvarigos, ICCS/NTUA vmanos@central.ntua.gr

Project Website: ict-serrano.eu

Social Media: twitter.com/ProjectSerrano www.linkedin.com/company/serrano-project

SERRANO

SERRANO PRESENCE

SERRANO partners present the project and disseminate its objectives and early results in various events.

SERRANO and BRAINE (braine-project.eu) EU projects are co-organizing the Workshop "Intelligent operations, security, and acceleration for edge computing" in the IEEE International Mediterranean Conference on Communications and Networking – Meditcom (meditcom2021.ieee-meditcom.org/).

The workshop seeks to attract high-quality contributions covering both theory and practice over edge computing. In particular, the topics of interest include, but are not limited to the following areas:

- Security, privacy and data integrity in the edge
- Orchestration of edge resources
- Network and cloud telemetry Integrating AI with Edge Computing
- Machine Learning integration with Edge Computing
- Application of AI/ML at the edge
- Edge intelligence
- Applications / VNFs deployed at the edge
- Acceleration of intensive workloads
- Networking programmability at the edge
- Verticals running in the edge

Nubificus Ltd - SERRANO's consortium partner - is co-organizing the 16th Workshop on Virtualization in High-Performance Cloud Computing - VHPC'21 (vhpc.org).

IEEE MeditCom

GPUs

FPGAs

Virtual Platforms

SERRANO

HPC

Smart NICs

This project has received funding from the European Union's Horizon 2020. Research and Innovation programme under grant agreement No 101017168.

Contact:
Prof. Emmanouel (Manos) Varvarigos
vmanos@central.ntua.gr

SERRANO 2nd Newsletter (May 21 – August 21)

SERRANO EU Project

2nd Newsletter (May '21 – Aug '21)

SERRANO

SERRANO PRESENCE

Events

On the 2nd of July 2021 SERRANO partners, ICCS/NTUA and Nubificus, made two presentations in the 16th Workshop on Virtualization in High-Performance Cloud Computing (VHPC'21), held in conjunction with the International Supercomputing Conference: i) Transparent deployment of applications in a secure and accelerated infrastructure of edge, cloud and HPC resources, ii) ML inference hardware acceleration with unikernels

On the 7th of July 2021 SERRANO hardware acceleration aspects where presented in SAMOS conference: A. Ferikoglou, et. al, Towards efficient HW acceleration in edge-cloud infrastructures: The SERRANO approach.

Meetings

On the 12th of July 2021, the 3rd plenary meeting of the ICT-40-2020 SERRANO Project (H2020 GA No 101017168) took place with all 11 partners in attendance.

Achievements

The Telekom Challenge (telekom-challenge.com) jury has nominated the Top 10 finalists. In recognition of their ideas for new products, Berlin-based O&O Software GmbH together with its Danish partner Chocolate Cloud ApS (the latter being a SERRANO partner) are among the best ten participants in the category Development, beating out competition from 35 countries and 5 continents.

at a glance

Project Title: *Transparent Application Deployment in a Secure, Accelerated and Cognitive Cloud Continuum*

Grant Agreement no: *101017168*

Topic: *ICT-40-2020 - Cloud Computing: towards a smart cloud computing continuum*

Duration: *01/01/2021 – 31/12/2023 (36 months)*

EC Contribution: *4.343.180,00 €*

Project Coordinator: *Prof. Manos Varvarigos, ICCS/NTUA vmanos@central.ntua.gr*

Project Website: *ict-serrano.eu*

Social Media: *twitter.com/ProjectSerrano*

www.linkedin.com/company/serrano-project

This project has received funding from the European Union's Horizon 2020. Research and Innovation programme under grant agreement No 101017168.

Contact:
Prof. Emmanouel (Manos) Varvarigos
vmanos@central.ntua.gr

SERRANO 3rd Newsletter (September 21 – December 21)

SERRANO 4th Newsletter (January 22 – April 22)

SERRANO 5th Newsletter
(May 22 – August 22)

SERRANO EU Project

5th Newsletter (May'22 – Aug '22)

SERRANO

SERRANO *PROGRESS*

Events

In May 2022, SERRANO project partner Chocolate Cloud had an invited talk in Aarhus University Digital Innovation Conference, presenting SERRANO innovations on "Multi-Party Computation meets Random Linear Network Coding for Secure Storage and Analytics".

In May 2022, SERRANO project partner NUBIFICUS participated in 18th Workshop on Virtualization in High-Performance Cloud Computing that took place in Hamburg, presenting SERRANO developments focusing on "Unified workload deployment on heterogeneous HPC clusters".

In June 2022, SERRANO project partner NUBIFICUS participated in the OpenInfra Summit Berlin 2022 with a presentation on "Interoperable Hardware Acceleration for Serverless" and on "Unikernels for Serverless Computing".

In August 2022, NUBIFICUS had an invited talk in 2nd International Workshop on Deployment and Use of Accelerators (DUAC), presenting "Accel: Interoperable Application Hardware Acceleration".

Meetings

The 5th plenary meeting of SERRANO project took place, in Athens, Greece, in ICCS/NTUA premises, on 25-26th May 2022.

at a glance

Project Title: Transparent Application Deployment in a Secure, Accelerated and Cognitive Cloud Continuum
Grant Agreement no: 101017168
Topic: ICT-40-2020 - Cloud Computing: towards a smart cloud computing continuum
Duration: 01/01/2021 – 31/12/2023 (36 months)
EC Contribution: 4.343.280,00 €
Project Coordinator: Prof. Manos Varvarigos, ICCS/NTUA vmanos@central.ntua.gr
Project Website: ict-serrano.eu
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This project has received funding from the European Union's Horizon 2020. Research and Innovation programme under grant agreement No 101017168.

Contact:
Prof. Emmanouel (Manos) Varvarigos
vmanos@central.ntua.gr

SERRANO 6th Newsletter
(September 22 – December 22)

SERRANO EU Project

6th Newsletter (Sep'22 – Dec '22)

SERRANO

SERRANO *INNOVATES*

Events

On September 2022, SERRANO co-organized with Horizon Cloud a Technical Community Event presenting the SERRANO project. Partners from NVIDIA, Aristotle University of Thessaloniki (AUTH) and ICCS – NTUA gave three presentations.

On November 2022, Serrano Project partner Aristotle University of Thessaloniki (AUTH) participated in the Circuits and Systems Seasonal 3-day school on "SMART Integrated Circuit Design Methodology: Enabling AI IC Design and Design Cycle Speed Up".

Meetings

The 1st SERRANO project review was held online on September 2022. The project received very good comments from the experts for its overall progress, technical achievements and innovations.

The 6th plenary meeting of SERRANO project took place, in Copenhagen, Denmark (NVIDIA) on 6-7th December 2022.

Achievements

SERRANO partners have a number of papers accepted and presented in conferences and journals.

Other

IDEKO Research Center posted a video describing how it takes advantage of the SERRANO platform, for the analysis and detection of anomalies in ball screws in real time.

at a glance

Project Title: Transparent Application Deployment in a Secure, Accelerated and Cognitive Cloud Continuum
Grant Agreement no: 101017168
Topic: ICT-40-2020 - Cloud Computing: towards a smart cloud computing continuum
Duration: 01/01/2021 – 31/12/2023 (36 months)
EC Contribution: 4.343.280,00 €
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This project has received funding from the European Union's Horizon 2020. Research and Innovation programme under grant agreement No 101017168.

Contact:
Prof. Emmanouel (Manos) Varvarigos
vmanos@central.ntua.gr

SERRANO 7th Newsletter
(January 23 – April 23)

SERRANO 8th Newsletter
(May 23 – August 23)

SERRANO EU Project

7th Newsletter (Jan'23 – April '23)

SERRANO

SERRANO *DISSEMINATION*

Events

In March 2023, NUBIFICUS and ICCS/NTUA participated in the organization of the Athens Unikraft Hackathon.

The hackathon was a free event focusing on students and professionals to learn more about operating systems, low-level programming, virtualization, unikernels, and the Unikraft open source project.

NUBIFICUS also participated with an oral presentation in FOSDEM 2023, Open source Software Developers' European Meeting, on "Hardware acceleration for Unikernels".

FOSDEM

Meetings

The 8th plenary meeting of the SERRANO project was hosted in IDEKO's premises in Elgoibar, Bilbao, Spain on 07th-08th March 2023.

Achievements

SERRANO partners have a number of papers accepted and presented in conferences and journals, including Advanced Information Networking and Applications 2023, Design, Automation and Test 2023 and others.

at a glance

Project Title: Transparent Application Deployment in a Secure, Accelerated and Cognitive Cloud Continuum

Grant Agreement no: 101017168

Topic: ICT-40-2020 - Cloud Computing: towards a smart cloud computing continuum

Duration: 01/01/2021 – 31/12/2023 (36 months)

EC Contribution: 4.343.180.00 €

Project Coordinator: Prof. Manos Varvarigos, ICCS/NTUA vmanos@central.ntua.gr

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This project has received funding from the European Union's Horizon 2020. Research and Innovation programme under grant agreement No 101017168.

Contact:
Prof. Emmanouel (Manos) Varvarigos
vmanos@central.ntua.gr

SERRANO EU Project

8th Newsletter (May'23 – Aug '23)

SERRANO

SERRANO *REACH*

Events

SERRANO project participated with ICCS/NTUA in the "Concertation and Consultation on Computing Continuum", organized within the context of the European, Cloud, Edge and IoT Continuum EUCloudEdgeIoT, in May 2023, in Brussels.

Also, in July 2023, SERRANO partner NUBIFICUS participated in Unikernel Community Meeting Aachen 2023.

Video

Prof. Manos Varvarigos presented SERRANO Project (H2020) in the Concertation and Consultation Meeting on Computing Continuum, from EUCloudEdgeIoT, in May 2023.

Youtube Video: https://www.youtube.com/watch?v=0A98KXQWMgI

Meetings

In May 2023, inbestMe hosted the 9th plenary meeting of SERRANO, in Barcelona. SERRANO partners discussed the project progress and the cutting-edge innovations and achievements in edge, cloud and HPC computing.

White Paper

ICCS/NTUA featured a SERRANO related article in the latest newsletter of the EUCloudEdgeIoT https://eucloudedgeiot.eu/a-paradigm-shift-for-the-iot-edge-cloud-continuum/

at a glance

Project Title: Transparent Application Deployment in a Secure, Accelerated and Cognitive Cloud Continuum

Grant Agreement no: 101017168

Topic: ICT-40-2020 - Cloud Computing: towards a smart cloud computing continuum

Duration: 01/01/2021 – 31/12/2023 (36 months)

EC Contribution: 4.343.180.00 €

Project Coordinator: Prof. Manos Varvarigos, ICCS/NTUA vmanos@central.ntua.gr

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This project has received funding from the European Union's Horizon 2020. Research and Innovation programme under grant agreement No 101017168.

Contact:
Prof. Emmanouel (Manos) Varvarigos
vmanos@central.ntua.gr

7 Updated Factsheet

SERRANO

ict-serrano.eu | Horizon 2020

Transparent Application Deployment in a Secure, Accelerated and Cognitive Cloud Continuum

SERRANO envisages the creation of an infrastructure agnostic automation process that will translate applications' high-level requirements to infrastructure-aware configuration parameters, which are then applied on secure and accelerated resources.

At a glance: SERRANO

Project Website: ict-serrano.eu

Project Coordinator:
Emmanouel (Manos) Varvarigos
Professor, ICCS/NTUA
vmanos@central.ntua.gr

Duration: 36 months

Partners:
Institute of Communication and Computer Systems – ICCS (Greece), Mellanox Technologies Ltd – MLNX (Israel), Chocolate Cloud ApS – CC (Denmark), Universitaet Stuttgart – USTUTT/HLRS (Germany), Aristotelio Panepistimio Thessalonikis – AUTH (Greece), INTRASOFT International SA – INTRA (Luxembourg), Inbestme Europe Agencia de Valores S.A. – INB (Spain), Innovation Acts Limited – INNOV (Cyprus), IDEKO S COOP – IDEKO (Spain), Universitatea de Vest din Timişoara – UVT (Romania), Nubificus Ltd – NBFC (United Kingdom)

Grant Agreement no: 101017168

Topic: ICT-40-2020 - Cloud Computing: towards a smart cloud computing continuum

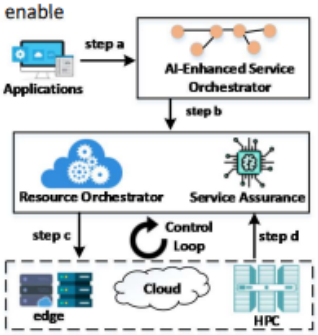
EC Contribution: 4,343,180.00 €

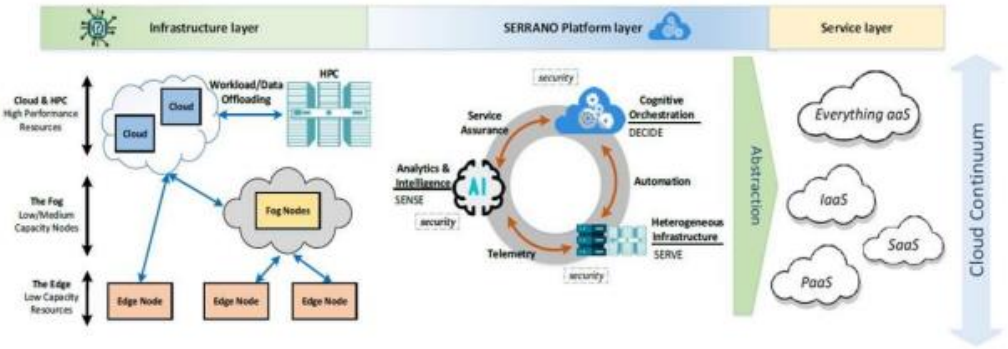
The Challenge

We are witnessing a wave of emerging cloud computing technologies and services that empower advanced applications from different vertical sectors, with diverse requirements. Also, there is a movement from top-down-designed architectures, applying centralized resource control, towards federations of loosely coupled autonomous or semi-autonomous systems, managed by multiple independent actors that are self-organized in a distributed manner. These trends give rise to several fundamental challenges that relate to the application deployment, the support of heterogeneous infrastructures and the provided security.

Vision

SERRANO targets the efficient and transparent integration of heterogeneous resources, providing an infrastructure that goes beyond the scope of the "normal" cloud and realizes a true computing continuum. SERRANO will introduce a novel ecosystem of cloud-based hardware and software technologies. This will enable application-specific service instantiation and optimal customizations, thus supporting highly demanding, dynamic and security-critical applications. The overall orchestration will be performed in a lean, automated, holistic and integrated manner.



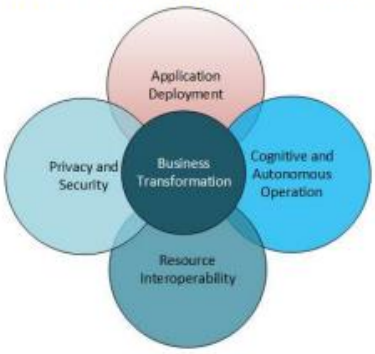


Project Objectives

SERRANO will create an abstraction layer that translates applications' high-level requirements to infrastructure-aware configuration parameters. The SERRANO platform will automatically determine the most appropriate resources to be used, and then transparently deploy workloads and coordinate data movement. Service assurance mechanisms based on artificial intelligence and machine learning techniques will facilitate the autonomous adaptation and management of the deployed services and resources. These mechanisms will be dynamically triggered by a data-driven cloud and network telemetry framework. SERRANO platform will also develop hardware and software-based mechanisms that provide security, privacy and multi-tenancy by design. In this way, applications and users will be able to maintain control over their data integrity and privacy when relying on publicly shared edge and cloud infrastructures. SERRANO will capitalize on the benefits offered by hardware accelerators used to execute prototype tasks that arise often in applications, coupled with novel transprecision computing mechanisms to exploit the accuracy versus resource usage tradeoff. Finally, SERRANO will demonstrate its advanced and innovative capabilities through three well-defined use cases in cloud storage services, fintech and manufacturing.

Technology Exploitation

SERRANO's modular-by-design approach supports the creation of a plethora of services that can be placed in the center of an innovative market ecosystem, which drives business innovation and enterprise transformation. These SERRANO services include: (i) secure, accelerated, federated infrastructures consisting of edge, cloud and HPC resources that also utilize novel cognitive mechanisms for the automation and optimization of their internal operations (SERRANO IaaS), (ii) domain specific and generic platforms for deploying and executing safety-critical, low-latency, data-intensive applications and other workflows (SERRANO PaaS), (iii) Cognitive Distributed Secure Storage as a Service (CDSSaaS) and Extreme Scale Analytics as a Service (ESAaaS) (SERRANO SaaS), (iv) business processes (e.g. for fintech and manufacturing) as a service (SERRANO BPaas). The SERRANO enabled IaaS, PaaS, SaaS and other product variants can be introduced in the today's and future's cloud computing market.



8 Updated Project Presentation

The SERRANO high-level project presentation is presented in the following pages.

SERRANO

Transparent Application Deployment in a Secure, Accelerated and Cognitive Cloud Continuum

Project Presentation

Call : H2020-ICT-2020-2
Topic : ICT-40-2020 - Cloud Computing: towards a smart cloud computing continuum
Type of Action: RIA

Grant Agreement no: 101017168
Project start: 01/01/2021
Duration: 36 months
Budget: 4,343,180.00
Site: ict-serrano.eu

Project Administrative Information

SERRANO

- **Project Name**: Transparent application development in a secure, accelerated and cognitive cloud continuum
- **Call identifier**: ICT-40-20 on "Cloud Computing: towards a smart cloud computing continuum"
- **Project Type**: Research & Innovation Action (RIA)
- **Grant Agreement Number**: 101017168
- **Project Coordinator**: Institute of Communication and Computer Systems – ICCS
- **Duration**: 36 months (01/01/2021 – 31/12/2023)
- **Funding from the EC**: 4,343,180 €
- **Total Budget of the project**: €4,343,180 €

SERRANO project presentation 2

Consortium (11 partners)

SERRANO

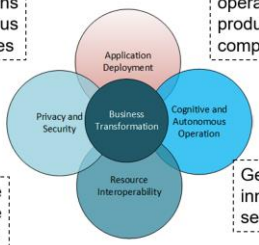
- Institute of Communication and Computer Systems – ICCS (Greece)
- Mellanox Technologies Ltd – MLNX (Israel)
- Chocolate Cloud ApS – CC (Denmark)
- Universitaet Stuttgart – USTUTT/HLRS (Germany)
- Aristotelio Panepistimio Thessalonikis – AUTH (Greece)
- INTRASOFT International SA – INTRA (Luxembourg)
- Inbestme Europe Agencia de Valores S.A. – INB (Spain)
- Innovation Acts Limited – INNOV (Cyprus)
- IDEKO S COOP – IDEKO (Spain)
- Universitatea de Vest din Timişoara – UVT (Romania)
- Nubificus Ltd – NBFC (United Kingdom)

SERRANO project presentation 3

Motivation

- Cloud transformation of enterprises towards the adoption of the cloud continuum
  - everything as a service
  - edge, cloud, high-performance cloud infrastructures

Develop and deploy cloud-native services/applications over heterogeneous interoperable infrastructures



Intelligent infrastructures operation can increase productivity and competitiveness

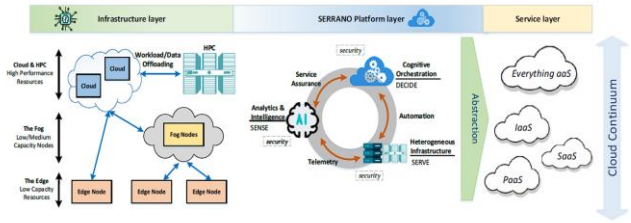
Privacy and security are critical for accelerating the adoption of cloud services

Generate business innovation and value for several application areas

SERRANO project presentation 4

SERRANO vision

- SERRANO envisages the creation of an abstraction layer that will fully exploit the available resources and automate their use
- This layer will be part of an infrastructure agnostic automation process
- It will translate applications' high-level requirements to infrastructure-aware configuration parameters that are then applied on secure and accelerated resources
- SERRANO targets a hierarchical architecture for end-to-end cognitive orchestration together with closed-loop control, based on the principles of observe, decide and act



SERRANO project presentation 5

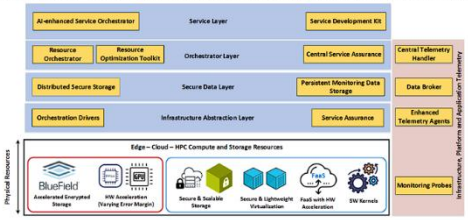
SERRANO objectives

- **Objective 1**: Define an intent-driven paradigm of federated infrastructures consisting of edge, cloud and HPC resources
- **Objective 2**: Develop security and privacy mechanisms for accelerated encrypted storage over heterogeneous and federated infrastructures
- **Objective 3**: Provide workload isolation and execution trust on untrusted physical tenders
- **Objective 4**: Provide acceleration and energy efficiency at the edge and cloud
- **Objective 5**: Cognitive resource orchestration and transparent application deployment over edge/fog-cloud/HPC infrastructures
- **Objective 6**: Demonstrate the capabilities of the secure, disaggregated and accelerated SERRANO platform in supporting highly-demanding, dynamic and safety-critical applications

SERRANO project presentation 6

SERRANO architecture

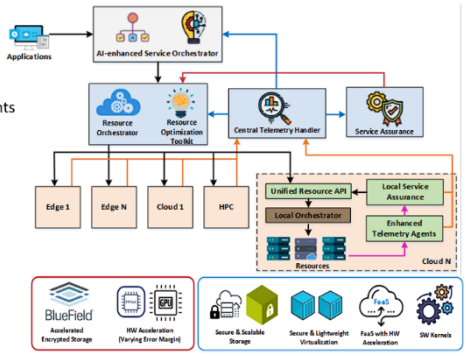
- The **Service Layer** analyses applications to automatically translate their high-level requirements into specific infrastructure operational constraints and orchestration objectives
- The **Orchestration Layer** ensures efficient service orchestration and resource management in the disaggregated and heterogeneous SERRANO infrastructure
- The **Secure Infrastructure Layer** contains all the mechanisms required to enable the secure and trustworthy sharing and access of the resources
- The **Infrastructure Abstraction Layer** abstracts the management and interaction with the individual resources
- The **Resource Layer** consists of heterogeneous computational, storage and networking resources



SERRANO project presentation 7

SERRANO ecosystem

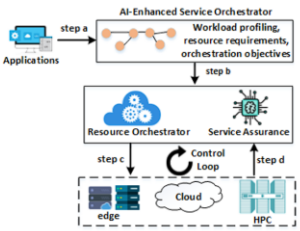
- Orchestration building blocks:
  - AI-enhanced Service Orchestrator
  - Resource Orchestrator, Local Orchestrators
  - Resource Optimization Toolkit
  - Central Telemetry Handler, Enhanced Telemetry Agents
  - Service Assurance
- SERRANO-enhanced resources:
  - Accelerated Encrypted Storage
  - Multi-level Approximate H/W Acceleration
  - Secure and Scalable Distributed Storage
  - Secured and Lightweight Virtualization
  - Software Kernels for computationally Intensive Tasks
- Exposed Software Development Kit:
  - Unified Resource API
  - Telemetry API
  - Distributed Secure Storage API



SERRANO project presentation 8

SERRANO lifecycle

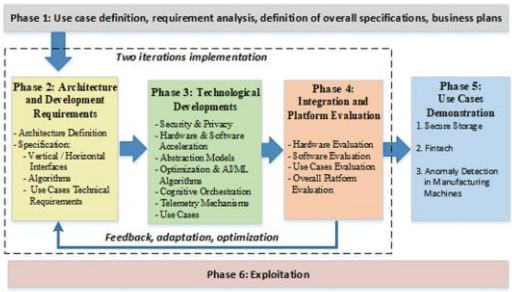
- Enable transparent application deployment: *develop once, deploy everywhere.*
- Lifecycle methodology:
  - **Step a**: Users provide applications along with a high-level infrastructure agnostic description of their requirements.
  - **Step b**: SERRANO profiles applications and decompose high-level requirements into resource and performance requirements.
  - **Step c**: SERRANO allocates resources to applications' and coordinates their deployment and data movement.
  - **Step d**: SERRANO uses real-time telemetry and proactively executes any required re-optimization.



SERRANO project presentation 9

SERRANO methodology

- **Phase 1 -** Initiates technical work:
  - UCs detailed definition and analysis
- Incremental implementation and evaluation.
- **Phase 2:**
  - Detailed SERRANO architecture
  - Ensure integration and interoperability
- **Phase 3** - Implements innovations
- **Phase 4** - Integrates and verifies technological developments
- **Phase 5:**
  - Full functionality demonstration
  - High impact components identification



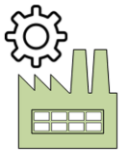
SERRANO project presentation 10

SERRANO (3) use cases

- **Secure Storage**
  - Provide secure and high-performance storage at the edge
  - Integrate SERRANO with a multi-cloud storage service

- **High-performance Fintech Analysis**
  - Apply AI and ML algorithms in financial operations
  - SERRANO will provide security and intelligent fintech app deployment

- **Machine Anomaly Detection in Manufacturing Environments**
  - Detect machine anomalies in real-time
  - SERRANO will orchestrate computations and data from high-frequency machine sensors



SERRANO project presentation 11

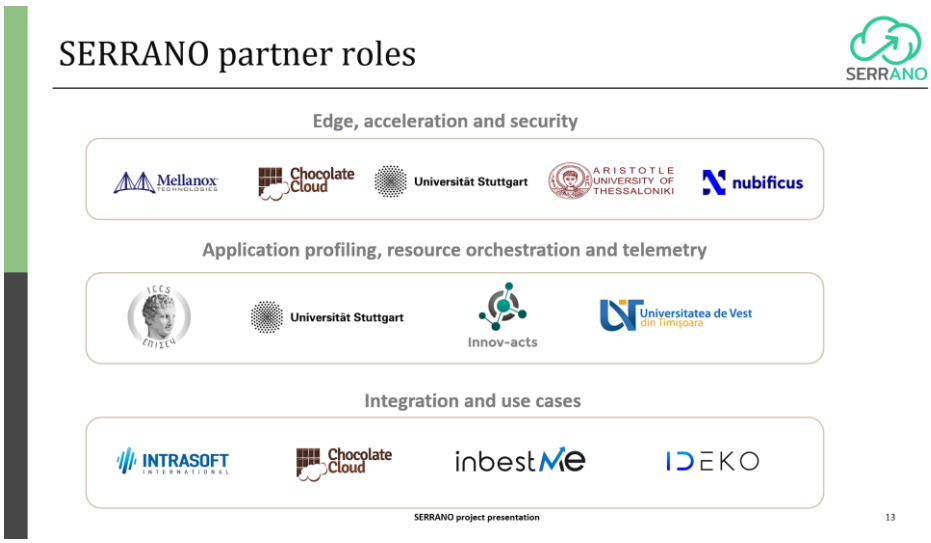
SERRANO market opportunities

- **Cloud market is soaring**
  - Public cloud service market will grow to $331.2B in 2022, attaining a compound annual growth rate (CAGR) of 12.6%
  - The cloud security market is expected to grow to $12.7 billion by 2022, with a CAGR of 25.5%

SERRANO will boost EU's cloud infrastructures and cloud-native applications markets towards the competitive global market landscape

- SERRANO will develop a novel ecosystem of hardware and software-based technologies, contributing to critical cloud related areas
- A vigorous multi-billion Euro market is addressed and leading industrial players are involved
- Near-market exploitation targeted through specific value propositions, validate by diversified use cases from respective vertical industries

SERRANO project presentation 12



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https://www.linkedin.com/company/serrano-project/
https://www.youtube.com/watch?v=ae35MflWsGY

9 SERRANO Banner

The project promotional material also includes a roll-up banner that provides a concise and visually appealing project overview. The SERRANO roll-up banner allows the project consortium to reach rapidly large audiences. The banner (Figure 27) clearly displays the project title and logo, provides a visual representation associated with the project objectives along with the project partners, and includes the project website where interested individuals can find more detailed project information. In addition, it provides funding information by clearly mentioning the funding agency that supported the research.

Figure 27: SERRANO roll-up banner

The roll-up banner has been used at various workshops and other events to attract attention and inform attendees about the key aspects of the SERRANO project. Figure 28 shows the banner in two events, the “Unikraft Athens Hackathon” that was co-organized by SERRANO on March 30-31, 2023 in Athens and the “EC Concertation and Consultation on Computing Continuum Event” on May 10-11, 2023 in Brussels.

Figure 28: Dissemination of SERRANO project in two events through its roll-up banner

10 Demonstration Videos

The consortium has also produced videos based on activities within the demonstration and evaluation phase (M31-M36). The videos present the outcomes of the project demonstrations. They aim to highlight the project achievements and technological developments and showcase the high-impact components and characteristics of the SERRANO platform. They provide more technical details compared to the promotional video.

The videos were prepared by the consortium and uploaded to the project's YouTube channel to be constantly available after the end of the project. In addition, the video links have also been added to the project's website and shared through the project's social media. The demonstration videos provide insight into the use of SERRANO components and the integration process of different services and are intended for technical/research audiences. The videos showcased not only core platform components but also important use cases.

The demonstration videos can be found at the following link:

- https://www.youtube.com/@serranoproject7470