1st Newsletter
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Welcome

Welcome to the ICOS project, we are really proud of sharing with you our first Newsletter. In this first edition of the Newsletter, we introduce you to the ICOS project and also include a brief overview about the architecture. Stay tuned to our website, `https://www.icos-project.eu/`. 21 leading European organizations from 11 countries join forces to tackle the main challenges of the IoT – Edge – Cloud paradigm, proposing an approach to embed a set of functionalities and define a brand new IoT-edge-Cloud Operating System (ICOS).

What is ICOS

A continuum, today also referred to as Cloud continuum, IoT continuum, Edge-to-Cloud or Fog-to-Cloud, is expected to provide the means for workloads execution and data processing both in the Edge and the Cloud. According to International Data Corporation's (IDC) forecast, the total Edge spending in the EU will reach 75 billion dollars by 2026. In Europe, Edge computing is expected to increase at an annual growth rate of 26,5%, from €815m in 2020 to €2.6bn in 2025 [1, 2]. Ensuring the security of data at the Edge as well as setting-up and maintaining an Edge infrastructure that can support highly demanding workloads are among the main barriers to the Edge adoptions in the enterprises [3].

Despite the intensive research activities and clear industrial trends in this field, performance and efficiency of resource usage as well as contextual intelligence of a continuum, remains a daunting challenge. This is not only due to the continuum being intrinsically heterogeneous, volatile, distributed and increasingly cognitive, but also due to the emerging request to be open and collaborative. Networking, AI, green computing and parallel processing are just some of the further research topics that need

Figure 1: ICOS logo

Figure 2: ICOS consortium

to be leveraged in order for the continuum to become mainstream.

There is a real need for an integrated platform to unleash the potential of European providers across the continuum. Currently missing from the Edge-Cloud scape is an open, non-proprietary, interoperable, robust, secure, sustainable multi-Cloud and multi-Edge continuum hosting solution, aimed at optimising the execution of workloads, especially in data intensive applications, and able to adapt to different strategies (e.g., execution time reduction, concurrent execution, Edge processing, fog security, locality, high resource utilisation, low latency and high energy efficiency), while being scalable, extensible and open to experimentation.

ICOS pushes the envelope towards the next generation of continuum management by proposing a high-level meta operating system (metaOS) to realise an extensible, open, secure, adaptable, AI-powered as well as well highly performant and technology agnostic continuum.

ICOS continuum will contribute to an open ecosystem, enabling interoperability with existing and emerging frameworks, towards a collaborative European Edge market scenario. It will provide new opportunities to European actors to establish.

The ICOS project will design, develop and validate a meta operating system for the continuum built upon the principles of openness, adaptability, data sharing and a future Edge market scenario, addressing the challenges of: i) devices volatility and heterogeneity, ii) continuum infrastructure virtualization and diverse network connectivity; iii) optimised and scalable service execution and performance, as well as resources consumptions, including power consumption; iv) guaranteed trust, security and privacy, and; v) reduction of integration costs and effective mitigation of Cloud provider lock-in effects.

Architecture

ICOS has been conceived as a dynamic metaOS distributed along the continuum. The major design principle in ICOS leverages the capabilities of both the Cloud (virtually unlimited computing and storage capacity, ubiquity) and the Edge (locality exploitation, latency and communication reduction, privacy preservation), to optimise both the usage of resources and the performance of the users' workloads. One of the most interesting characteristics of ICOS is its elasticity, being able to manage dynamic and mobile nodes efficiently
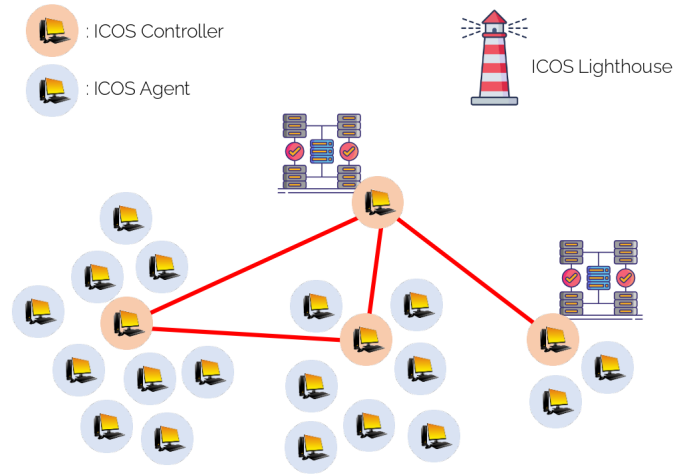

Figure 3: ICOS continuum nodes

and seamlessly. Thus, nodes can join or leave the system dynamically, or move throughout the continuum, establishing new proximity-based relationships between other nodes in different geographic locations. To realise these scenarios, two types of nodes will compose the continuum (Figure 1): the Agents that execute the users' workloads, and the Controllers that are responsible for managing the agents. The architecture also includes a 'Lighthouse' functionality to simplify and automate the dynamic on-boarding, disconnection, re-connection and migration of ICOS Agents to ICOS Controllers.

References

[1] Rowan, Brendan, Álvarez, José Enrique, & Kušíková, Zuzana, 2023. *Technology scoping paper (1.0)*. *Zenodo*. https://doi.org/10.5281/zenodo.8020703

[2] *Worldwide Edge Spending Guide (2021)*. *IDC*. https://www.idc.com/getdoc.jsp?containerId=IDC_P39947

[3] *Future Enterprise Resiliency and Spending Survey (2022)*. *IDC*. https://www.idc.com/getdoc.jsp?containerId=US48925022