

Autopoietic Cognitive Edge-cloud Services

**A secure, resilient and
privacy-compliant European
Data Management and
Processing Infrastructure**

ACES researches and develops an open common Artificial Intelligence and Machine Learning enabled architecture to respond to the increasing need of cloud services at the edge, independent of any platform. It provides end-to-end transaction resilience; reliability and stability of automation in cloud management; and secure flows of sensitive data and applications.



About Us

ACES is a three-year research and innovation project funded under the Horizon Europe Framework Programme, Programme HORIZON-CL4-2022-DATA-01, project ID: 101093126. It is promoted by a consortium of 12 organisations, small and medium businesses, research and technology institutions, academia and industry, who are leaders in computer engineering, smart manufacturing, public policy, technological development, innovation management, business information system security and public administrations clusters.

Value Proposition

- Innovative cloud-edge service based on optimised computing and network management, storage, and analytics, using AI and M/L techniques.
- Autopoiesis to manage resources and workloads in respect to edge-relevant requirements such as latency, energy efficiency, security and throughput.
- Optimised data management, storage, replication and data movement.
- Research services to improve the experience of operators, software and application developers as well as end-users.
- Demonstrated effectiveness in concrete edge-cloud application use cases.

Context and issues

ACES undertakes research and technological innovation to respond to the increasing need of edge-cloud computing and data management and the demand of edge services. ACES edge-cloud data and application services have the potential to enable a new infrastructure model, capable of guaranteeing end-to-end transaction resilience.

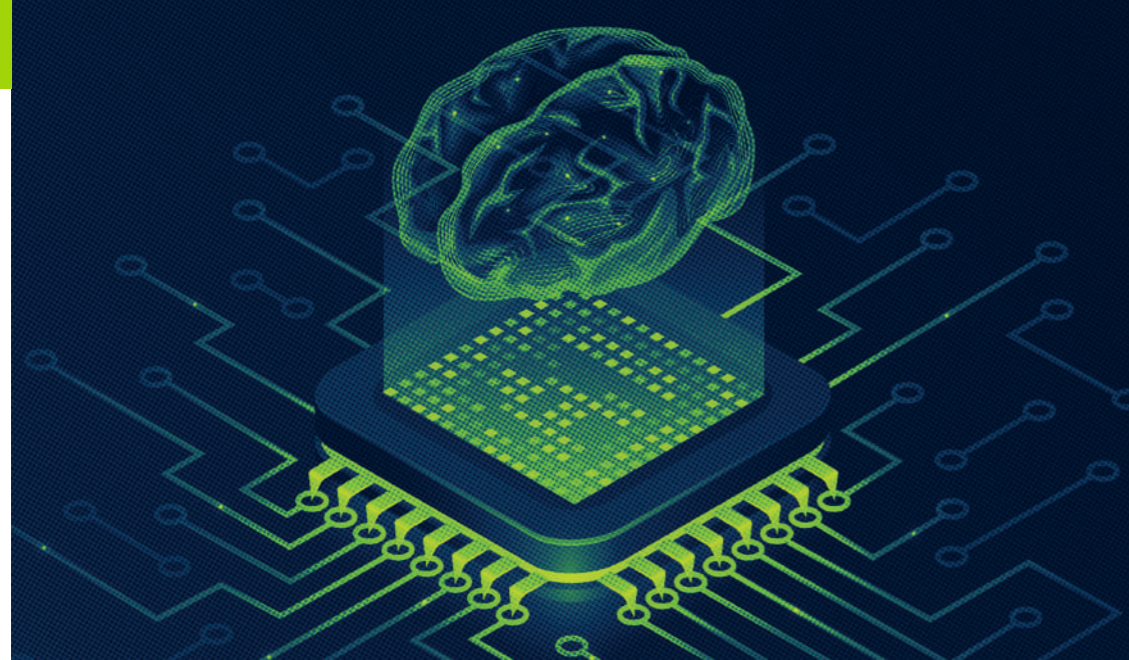
The ACES solution provides autonomy and self-regulating mechanisms that provide systems stability, locally and edge-wide. The requirements include the need for a horizontal flow of data and applications between sites as well as tackling issues of bandwidth, energy efficiency, security, and privacy.

Furthermore, the autonomous operations on the platform need to be clearly explainable to operators, application developers and end-users and low-overhead is required in terms of costs, latency, energy, labour.

Solution

ACES will provide an edge-services cloud with hierarchical intelligence, specifically autopoiesis and cognitive behaviours to manage and automate the platform.

These solutions include: Autopoiesis-based edge-services cloud; awareness tools, AI/ML agents for workload placement, service and resource management, data and policy management, telemetry and monitoring; Autopoiesis agents to safeguard stability in situations of extreme load and complexity; Swarm technology-based methodology and implementation for orchestration of resources; Edge-wide workload placement and optimization; App store for classification, storage, sharing and rating of AI models used in ACES.



Impact

The aim of ACES is to develop a distributed, opportunistic, collaborative, heterogeneous, self-managed, self organising edge services environment, primarily edge-to-edge and secondly on the edge-to-cloud continuum.

The expected impacts of this implementation are:

- Improved placement of Europe in the delivery of secured edge-cloud service platforms in the global scenario.
- A reinforced capability of Europe to have available technical, computational and data transmission means to manage urgent societal challenges.
- Availability of more effective technologies and tools to manage distributed cloud systems at the edge.

More specific impacts of ACES concern:

- the energy sector, facilitating the transition towards a system capable of optimising the relationship between supply and demand and the integration of sustainable energy sources.
- the more general impact on the European Green Deal, driving the concept of smart infrastructure and decentralised energy production.
- impact on sustainable development goals.

Key Outcomes



Autopoietic edge-cloud data and application service platform.



Management agents and tools for awareness; Artificial Intelligence and Machine Learning enabled tools to handle workload, service and resource management, data and policy management, telemetry and monitoring workload placement.



Agents that maintain stability under conditions of extreme complexity and load.



Swarm technology-based solutions for orchestration of resources in the edge and policy handling.



Edge-wide workload placement and optimization service.



App store for ACES Artificial Intelligence models classification, storage, sharing and rating.

Use cases

The Use Cases test and demonstrate the effectiveness and generalisability of the ACES design and technological solutions. They are based on three real-life application scenarios that take advantage of cognitive edge services with different levels of autonomy and actionability within the services, the edge service stack and the hardware. These use cases will develop dedicated and, geographically distributed edge cloud to demonstrate its effectiveness and efficiency to technologists and end-users and they will be documented appropriately to prove the transferability to other industries and sectors.

(UC1) Market place and asset distribution.

(UC2) Distributed process management.

(UC3) IoT based asset monitoring and management.

The pillars of ACES



Develop a new modular edge services platform

ACES develops a modular edge-services cloud which will support multiple architectural patterns for creating ad-hoc edge clouds in one site, and across multiple sites. The autopoiesis enables an autonomous configuration, orchestration and management collecting metrics and generating knowledge that intelligent agents use to execute edge-services and cloud requirements such as energy efficiency, availability, scalability, latency, data centricity, security and data protection. The event-driven data-centric architecture will be designed to have high levels of automation and autonomy and supports human operator control.



Creating specific workload management modules

The ACES solution builds on six modules: edge resource collaboration, service deployment, resource clustering at scale, workload placement, network control, workload optimization, with a view to optimising the data management, data storage, data replication.



Optimize the data management, data storage, data replication

The ACES project will provide a distributed storage framework that has “knowledge” of the location of data in several ways: physical location of the data within the edge and across the different edge locations. Personal data will be linked to the current location the user is accessing ACES services from. ACES will develop and deploy data migration and replication solutions to enhance the reliability from some of the ad-hoc resources employed at the edge. Metadata about the data access requests will be logged into a distributed ledger (blockchain). Various access authorizations will grant different control over access to data and data placement on edge systems to ensure privacy. Range of services to be produced: Distributed storage and data movement; Data life cycle management for the edge; Data slicing and management at scale; Telemetry; Edge acceleration; AI security.



ACES improves the experience of operators, end-users and developers by providing specific research services

ACES aims to develop a set of tools for ACES platform operators to check Artificial Intelligence/ Machine Learning models against existing ones. Such set of tools for software developers addresses two areas: networking and observability; and offer distributed transaction monitoring, performance and latency optimization, root cause analysis, service dependency analysis, distributed context propagation. With a view to optimising the data management, the following services will be provided: application store; application monitoring; network function synthesis; visualisation of workload placement and orchestration.



Test and demonstrate the effectiveness and generalisability of ACES by evaluating three real-life use cases of cognitive edge-services

ACES develops three different use cases that are comprehensive enough to belong to different sectors and with different applications.
Use case 1: Market place; distribution dedicated to the energy grid;
Use case 2: Distributed Process Management of the electric market management;
Use-case 3: An IoT based Asset Monitoring and Management the introduction of Advanced Metering Infrastructure data along with data from grid-edge sensors and GIS systems has allowed for faster outage detection, accurate outage prediction and more reliable investment planning.

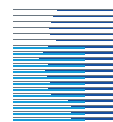
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