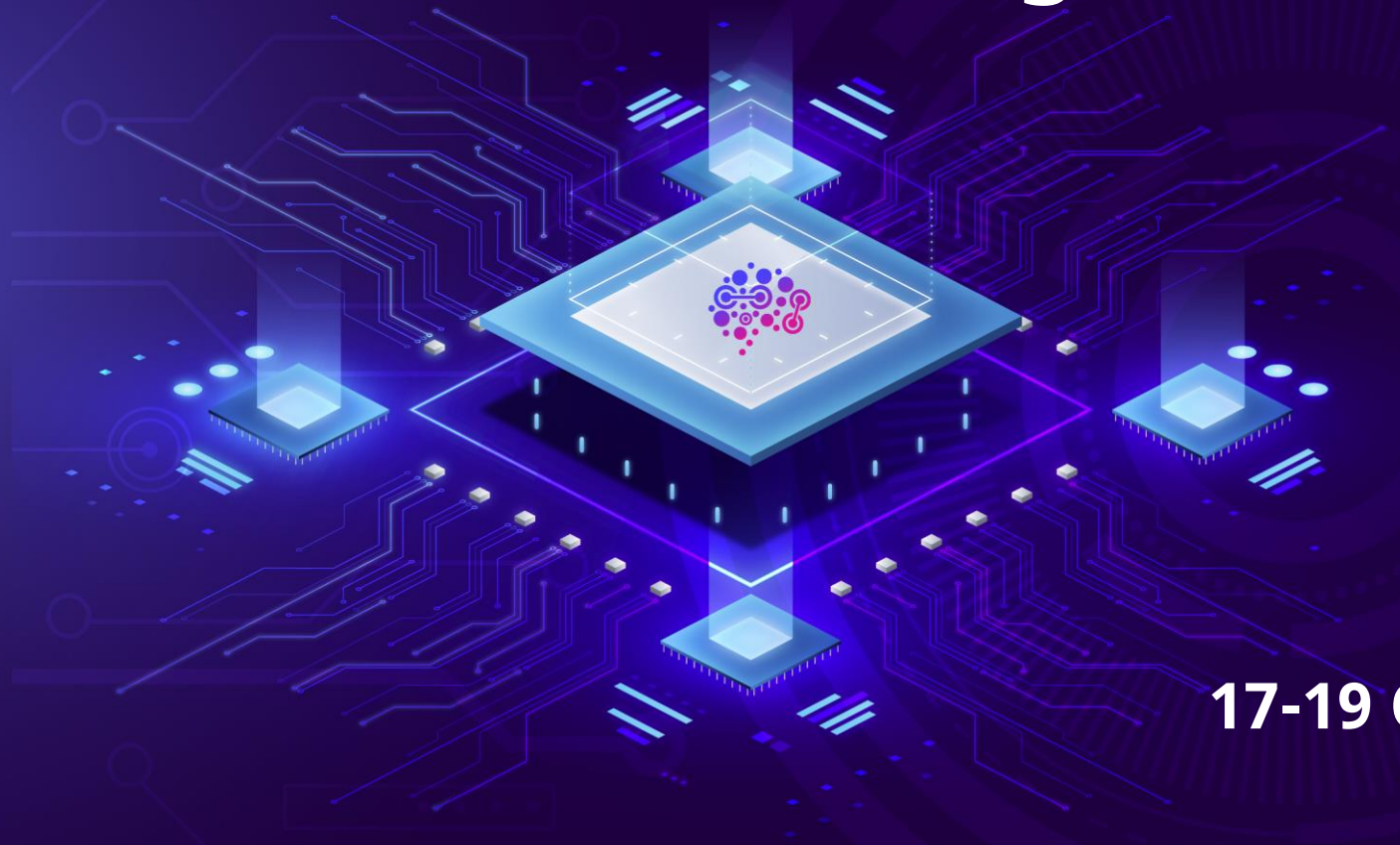
European Conference on EDGE AI Technologies and Applications - EEAI



Advancing emerging edge AI technologies and driving next generation intelligent applications.

17-19 October 2023, Athens, Greece

European Conference on EDGE AI Technologies and Applications - EEAI

Advancing Edge AI Technologies and Applications

Ovidiu Vermesan, SINTEF, Norway

17-19 October 2023 Athens, Greece

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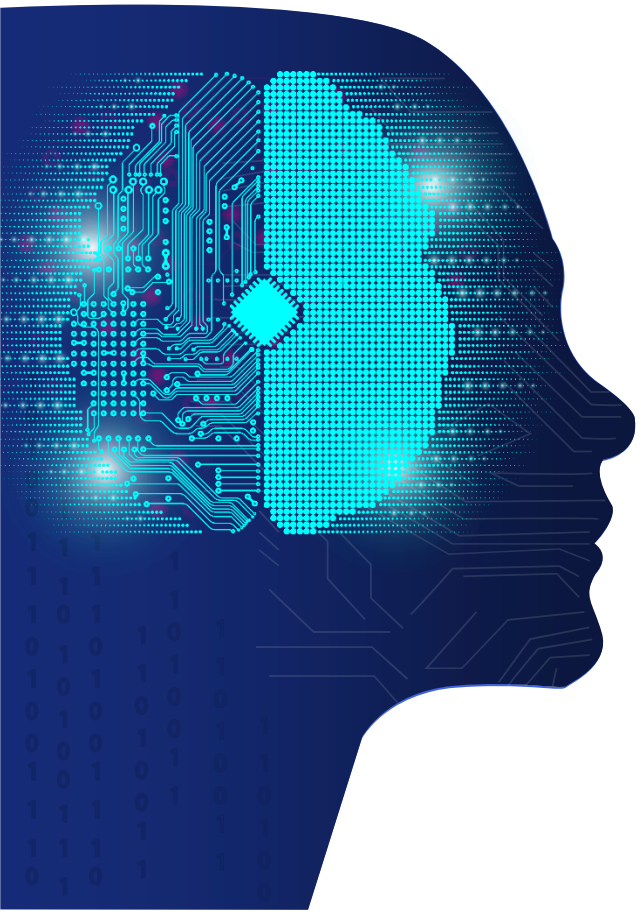
Presentation Outline



- AI-ML-DL
- Edge Intelligence Evolution
- Edge AI Defined
- The Emergence of Edge AI
- Edge AI Demystified
- Trends – Challenges - Future Research

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AI – ML - DL

- Artificial Intelligence started to be developed around 1950s.
- AI represents simulate intelligence in machines
- AI is a subset of data science.
- Aim is to build machines which are capable of thinking like humans.

Artificial Intelligence

- Machine Learning started to be developed around 1960s.
- Machine learning is the practice of getting machines to make decisions without being programmed.
- Machine learning is a subset of AI and Data Science.
- Aim is to make machines learn through data so that they can solve problems.

Machine Learning

- Deep Learning started to be developed around 1970s.
- Deep Learning is the process of using artificial neural networks to solve complex problems.
- Deep Learning is a subset of Machine Learning, AI and Data Science.
- Aim is to build neural networks that automatically discover patterns for feature detection.

Deep Learning

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AI-ML-DL

Artificial Intelligence

Engineering of making intelligent machines and programs

Machine Learning

Ability to learn without being explicitly programmed

Deep Learning

Learning based on deep neural network

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Edge Intelligence Evolution

Collaborative Environments

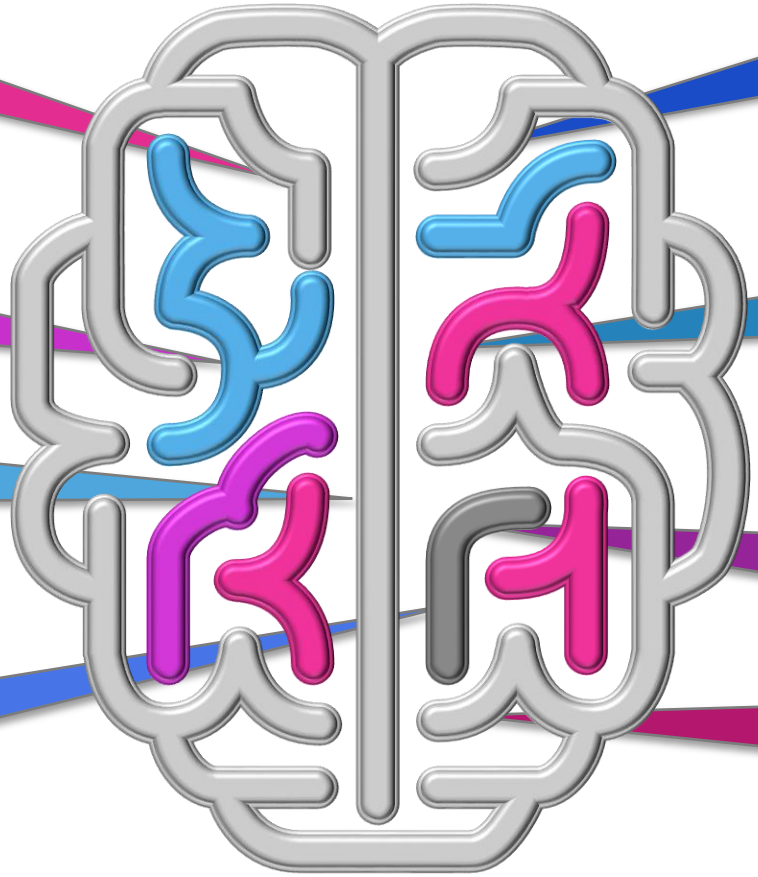
Immersive physical-digital-virtual continuum.

Intelligent.
Integrated and integral edge AI, analytics, decision and cognitive capabilities .

Distributed.
Architectures, computing, storage, connectivity, decision making.

Immersive.
Immersion into virtual reality and physically present in a non-physical world.

Trustworthy.
System dependability. Standards, industry best practices laws, regulations. Explainability and Interpretability.



Hyperconnected.
Connected to multiple edge intelligent devices using multiple connectivity protocols.

Digital.
Digital representations, modelling and simulations in heterogenous platforms.

Autonomic.
Self-X including self-directed behaviour and autonomous functions.

Ubiquitous.
Omnipresence - being present anywhere, everywhere, anytime.

Integrated Ecosystems

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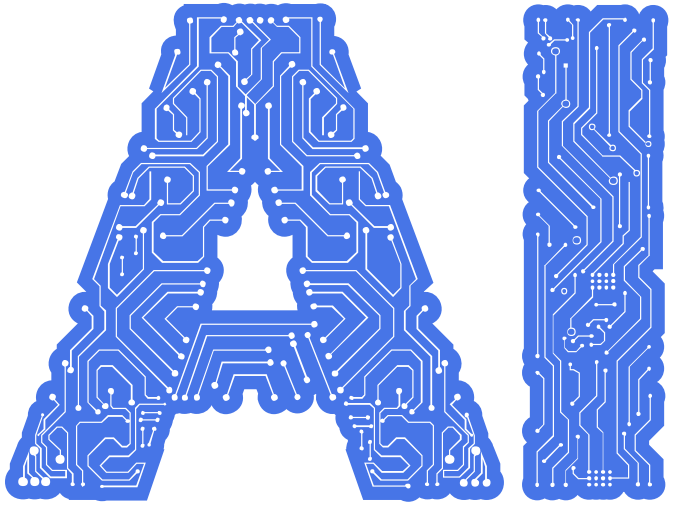
Edge AI

Edge



Edge AI combines AI, IoT and edge computing technologies and provides real-time collection, processing, analytics and decision-making. The applications that accelerate the edge AI developments are autonomous systems (e.g., autonomous vehicles, internet of robotic things, swarm colonies of things), smart energy, industrial manufacturing, intelligent buildings, etc.

01 Reduces latency, bandwidth by introducing cost-effective and efficient low power HW/SW/AI solutions allowing processing and analysing data locally.

02 End-to-end edge AI architecture from device to system. HW/SW/AI co-design methodologies. Use of multiple toolchains, frameworks and platforms.

03 Verification, validation and testing in heterogenous and dynamic environments.

04 Deploy edge AI-powered applications that perform complex tasks in various industrial sectors.

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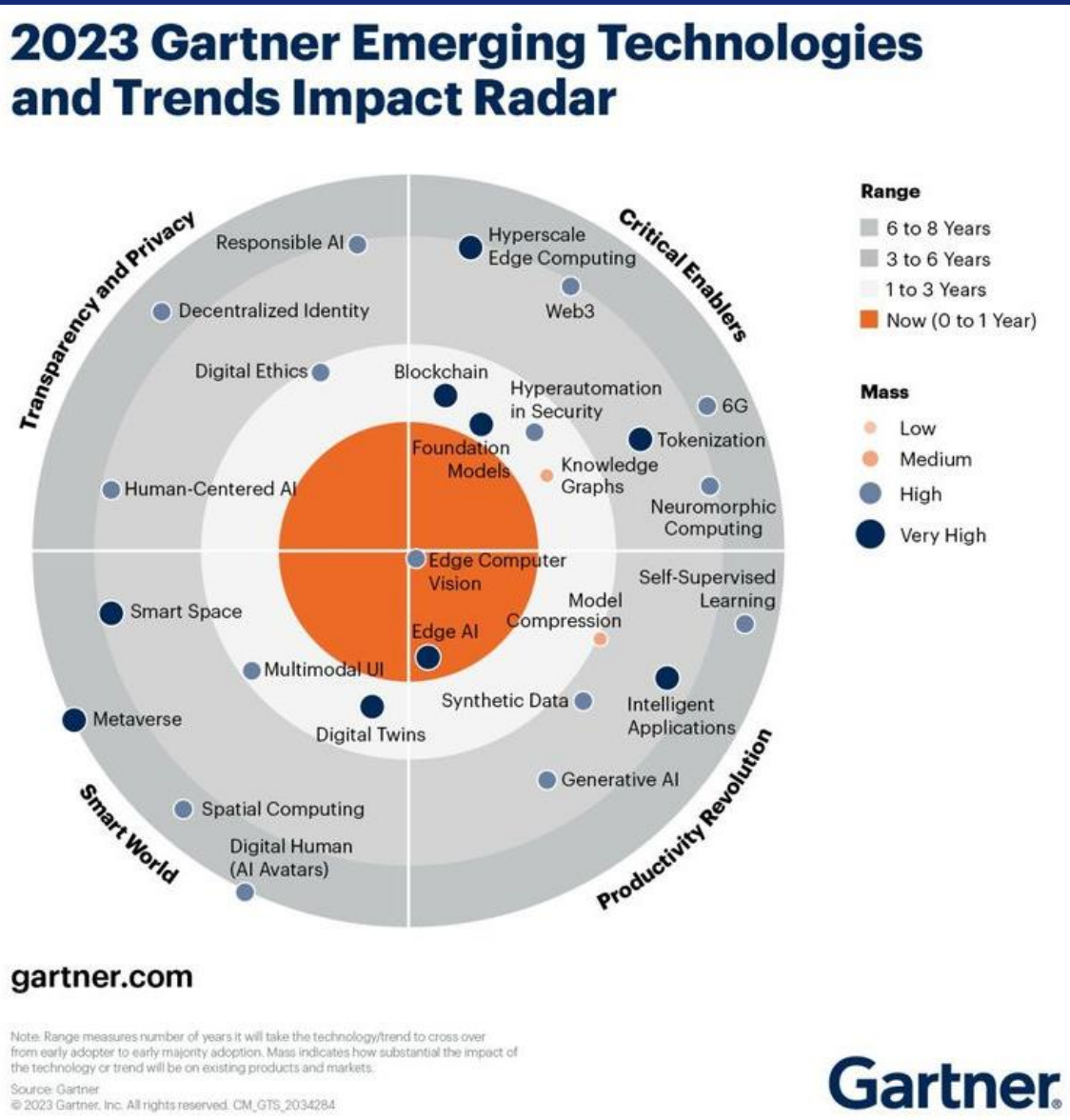
The Emergence of Edge AI



- Gartner's Emerging Technologies and Trends Impact Radar points to edge AI as the next breakthrough technology.
- The growing demand for real-time AI solutions and the need for decentralised data processing, AI at the edge has been positioned as a critical technology.
- Intelligent machines, artificial intelligent IoT (AIoT) and autonomous systems are seen the next-generation edge AI use cases.
- Edge AI is driving the transformation of industrial processes, leading to increased efficiency, productivity, and competitiveness through informed decisions in real-time, improve processes, and optimised operations.

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Edge AI Demystified

Edge AI Evolution

- What is edge AI.
- Introduction to edge AI levels.
- Types of edge AI technologies.
- Edge AI VS edge ML vs edge DL
- Edge AI applications.
- Edge AI use cases and developments.
- Edge AI trends and challenges.
- Edge AI future research directions.

Edge Machine Learning

- Edge AI ML
- How edge ML is applied to micro-, deep- and meta-edge.
- Edge ML algorithms.
- Edge ML use cases
- Choosing edge ML algorithms
- Why to use decision tree algorithm learning
- Challenges and limitations of edge ML.
- Application of edge ML.
- How edge AI ML evolves.
- Edge ML future research directions.

Edge Deep Learning

- Edge DL.
- Edge DL process,
- Classification of Neural Networks
- Types of edge DL networks
- Feed-forward neural networks
- Recurrent neural networks (RNNs)
- Convolutional neural networks (CNN)
- Reinforcement Learning
- Examples of edge DL applications
- Why is edge DL important?
- Limitations of edge DL.
- Edge DL future research directions.

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Trends

Challenges

Future Research

- Edge AI ML models trained on reduced datasets and optimised to accomplish specific tasks or maximise specified reward functions.
- New edge AI methods for increasing the capacity for generalising or transferring learning from a training task to a new one.
- Edge AI energy-efficient federated learning.
- Novel heterogeneous edge AI energy-efficient hardware architectures and circuits combining new computing paradigms.
- Edge AI collective intelligence- combining intrinsic and extrinsic intelligence solutions.
- Self-supervised learning, deep reinforcement learning for edge AI.
- Edge AI meta-learning, continual-learning and multitask learning.
- Real-time techniques for edge AI models updatability and upgradability.
- Reconfigurable edge AI systems.
- Immersive edge AI technologies.

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Trends

Challenges

Future Research

- Generative edge AI systems.
- Self-replicating edge AI systems that enables a set of AI-based algorithms to produce other tools.
- Generative edge AI using transformers with models down to embedded chips.
- Improving edge AI algorithms accuracy rates on reduced datasets.
- Edge AI trade-off optimization considering performance, computing resources, energy-efficiency, precision and reduced data sets.
- Edge AI mesh – edge AI mesh nodes able to make their own decisions depending on the data it receives and the model that has been installed.
- Edge AI lifetime management for maintenance of the training models.
- Further specialisation of edge AI hardware acceleration considering flexibility/reconfigurability and moving AI functions closers to sensors and actuators.
- Heterogeneous integration addressing the need to distribute intelligence, inside edge AI processing AIoT nodes, sensors and actuators.
- Development of interoperable tools and platforms with open interfaces for edge AI design, verification, validation, testing, deployment and maintenance.
- Trustworthy, explainable, interpretable edge AI.

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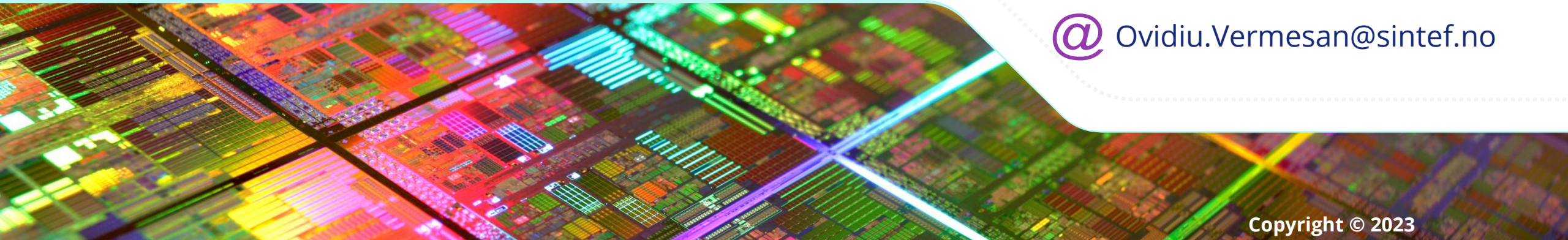
EDGE AI

Thank You

For your attention



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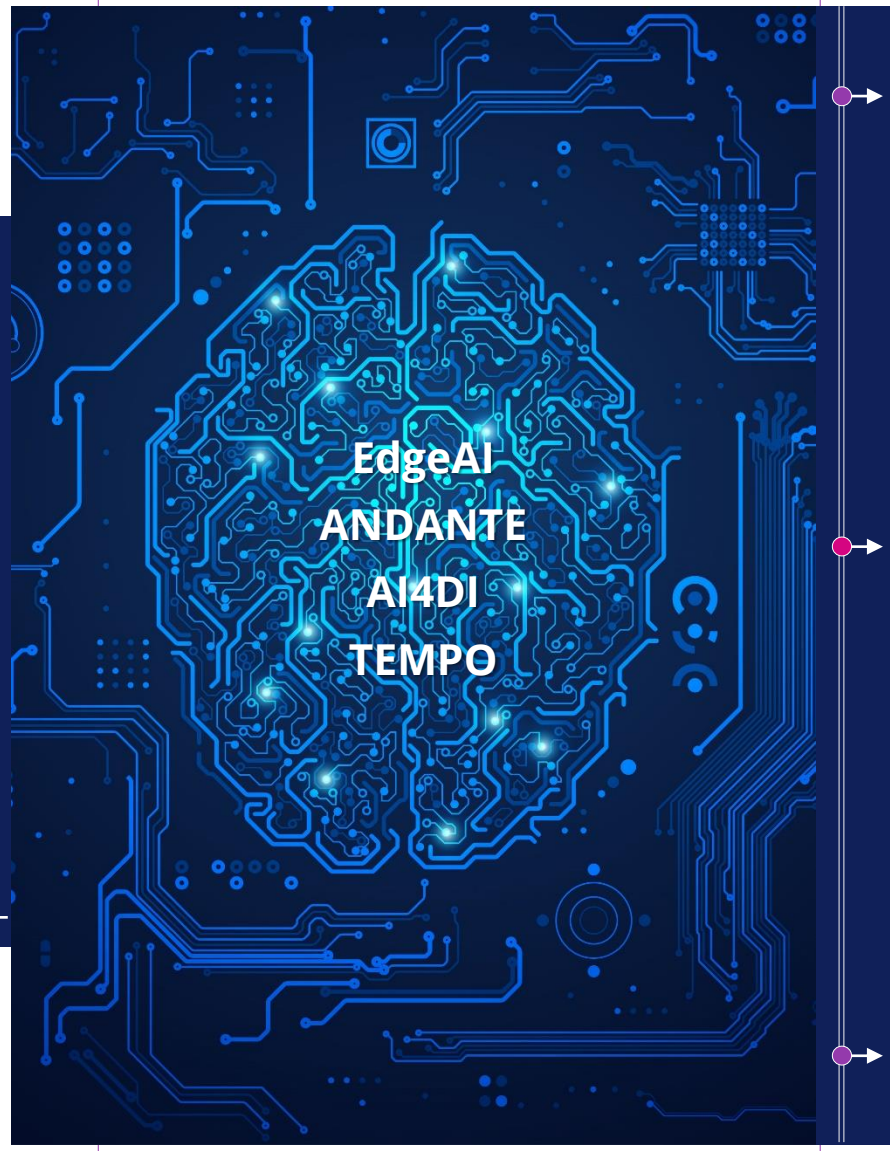

EdgeAI (Edge AI Technologies for Optimised Performance Embedded Processing) develops new electronic components and systems, processing architectures, connectivity, software, algorithms, and middleware through the combination of microelectronics, edge AI, embedded systems, and edge computing. www.edge-ai-tech.eu

The ANDANTE project has received funding from the ECSEL Joint Undertaking (JU) under grant agreement No 876925. The JU receives support from the European Union's Horizon 2020 research and innovation programme and Belgium, France, Germany, The Netherlands, Portugal, Spain, Switzerland. www.andante-ai.eu

The TEMPO project has received funding from the ECSEL Joint Undertaking (JU) under grant agreement No 826655. The JU receives support from the European Union's Horizon 2020 research and innovation programme and Belgium, France, Germany, The Netherlands, Switzerland. www.tempo-ecsel.eu

The AI4DI project has received funding from the ECSEL Joint Undertaking (JU) under grant agreement No 826060. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the national authorities. www.ai4di.eu

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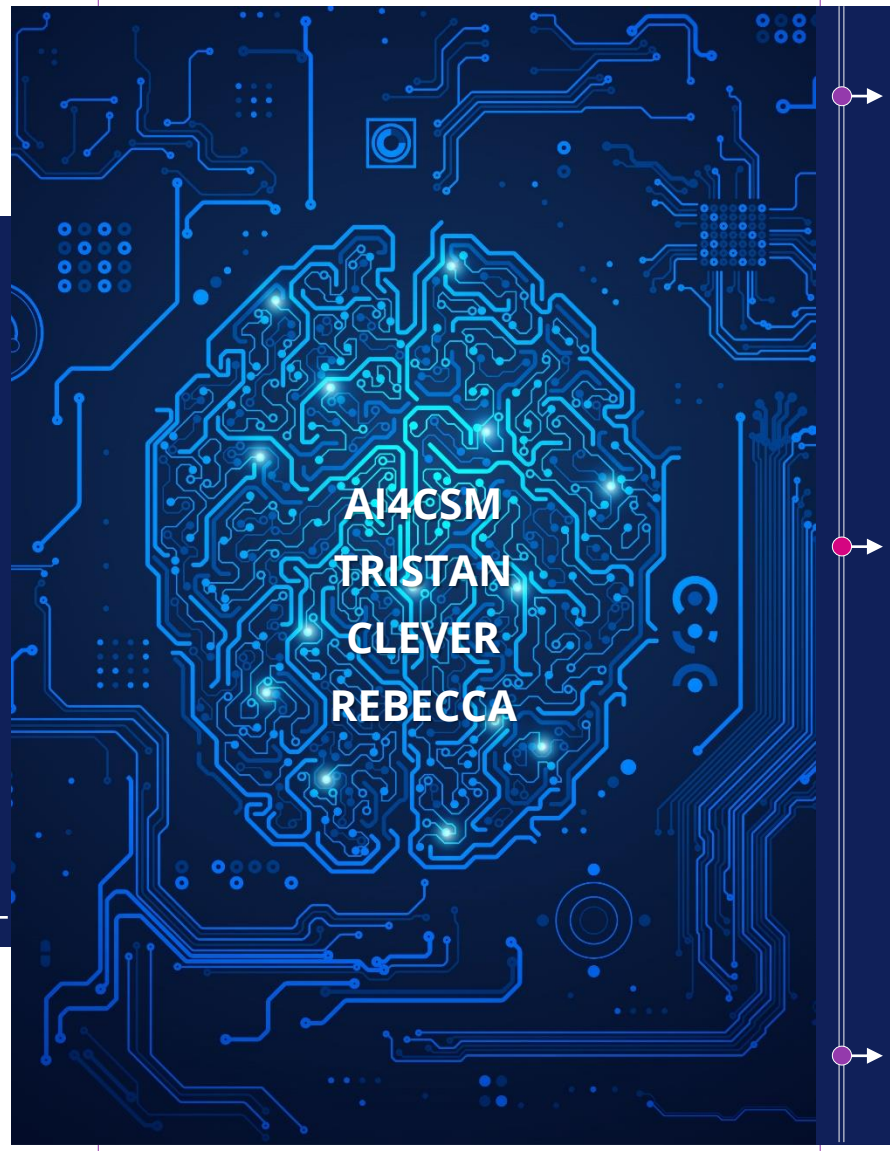

AI4CSM (Automotive Intelligence for Connected Shared Mobility) develops advanced electronic components and systems (ECS) and architectures for future mass-market ECAS vehicles based on sensor fusion and perception platforms, efficient propulsion and energy modules, advanced connectivity and trustworthy AI techniques and methods. www.ai4csm.eu

TRISTAN aims to expand, mature, and industrialize the European RISC-V ecosystem to compete with commercial options by leveraging the Open-Source community to gain productivity and quality. A European strategy for RISC-V designs will be defined, creating a repository of industrial rate building blocks for SoC designs in various application domains. www.tristan-project.eu

CLEVER (Collaborative edge-cLoud continuum and Embedded AI for a Visionary industry of thE futuRe) proposes innovations in hardware accelerators, design stack, and middleware software that revolutionize the ability of edge computing platforms to operate federated, leveraging sparse resources that are coordinated to create a powerful swarm of resources. www.cleverproject.eu

REBECCA (Reconfigurable Heterogeneous Highly Parallel Processing Platform for safe and secure AI) aims to democratize the development of edge AI systems and create a complete hardware and software stack centered around a RISC-V CPU, which offer higher performance, energy efficiency, safety, and security than existing systems. www.rebecca-chip.eu

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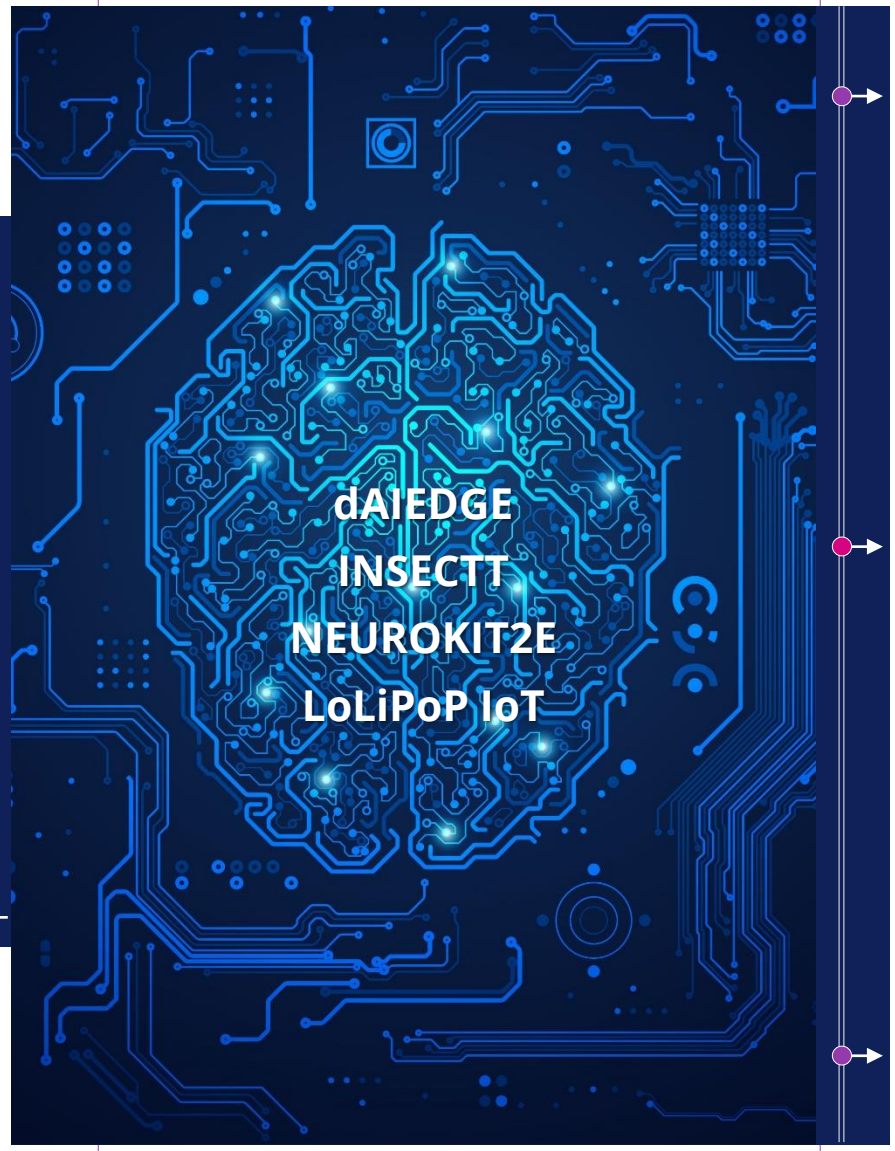

dAIEDGE

dAIEDGE is the European Network of Excellence for distributed, trustworthy, efficient, and scalable AI at the Edge and promotes the application, development, and deployment of Artificial Intelligence (AI) on edge computing platforms.

InSecTT

INSECTT (Intelligent Secure Trustable Things) provide intelligent, secure, and trustworthy systems for industrial applications to provide comprehensive cost-efficient solutions of intelligent, end-to-end secure, trustworthy connectivity and interoperability to bring the Internet of Things and Artificial Intelligence together. www.insectt.eu

NEUROKIT2E

NEUROKIT2E (Open source deep learning platform dedicated to Embedded hardware and Europe) proposes a Deep Learning Platform for Embedded Hardware around an established European value chain (AI HW/SW). The solutions developed support neural network design, optimisation, and implementation on constrained HW.

LoLiPoP-IoT

The objectives of LoLiPoP IoT (Long Life Power Platforms for Internet of Things) are to develop energy harvesting-based innovative Long Life Power Platforms that enable retrofit of wireless sensor network edge devices for asset tracking, condition and performance monitoring. www.lolipop-iot.eu

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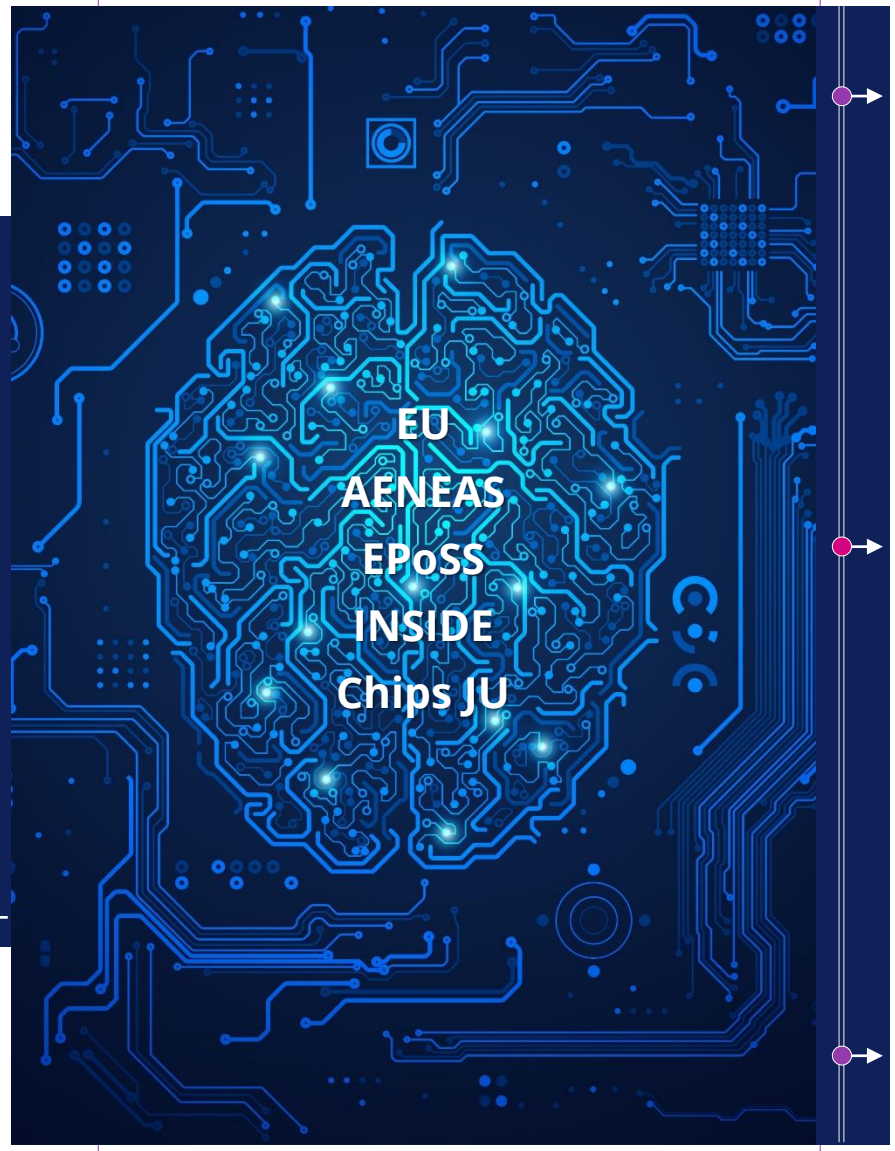
Supporting Organizations



AENEAS standing for Association for European NanoElectronics ActivitieS, is an industrial Association, established in 2006, providing unparalleled networking opportunities, policy influence & supported access to funding to all types RD&I participants in the field of micro and nanoelectronics enabled components and systems. https://aeneas-office.org/

The European Technology Platform on Smart Systems Integration is an industry-driven policy initiative, defining research, development and innovation needs as well as policy requirements related to Smart Systems Integration and integrated Micro- and Nanosystems. The main objective is to develop a vision and to set up a Strategic Research Agenda. www.smart-systems-integration.org

Inside Industry Association is the European Technology Platform for research, design and innovation on Intelligent Digital Systems and their applications. The Association is a membership organisation for the European research and innovation actors with more than 200 members and associates from all over Europe. www.inside-association.eu

Chips Joint Undertaking supports research, development, innovation, and future manufacturing capacities in the European semiconductor ecosystem. Launched as part of the Chips for Europe Initiative, it confronts semiconductor shortages and strengthens Europe's digital autonomy, engaging a significant EU, national/regional and private industry funding of nearly €11 billion. https://portal.chips-ju.europa.eu/

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