AI, IoT, Advanced Control and Edge Computing
in the ECSEL programme

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Intro

- AI
  - using AI technology
  - enabling AI technology
- IoT
  - HW for IoT
  - IoT solutions
  - SW for IoT
- enabling Edge computing
- Conclusions

Using Artificial Intelligence tec

- **RobustSENSE (2014-1) Robust and Reliable Environment Sensing and Situation Prediction for Advanced Driver Assistance Systems and Automated Driving** develop the necessary algorithms for scene understanding, situation prediction and behaviour planning, which allow a safe functional degradation of assistance systems,
- **ASTONISH (2015-1) Advancing Smart Optical Imaging and Sensing for Health** Patient movement correction and 3Dtracking will be developed based on generic image analysis algorithms.
- **AutoDrive (2016-1) Advancing fail-aware, fail-safe, and fail-operational electronic components, systems, and architectures for fully automated driving to make future mobility safer, affordable, and end-user acceptable.** initiate standards and provides the components and subsystems for automated driving
- **CONNECT (2016-1) Innovative smart components, modules and appliances for a truly connected, efficient and secure smart grid.** application of the cooperation algorithms together with the utilization of the results obtained by the machine learning algorithms will result in an average 40% peak demand reduction from the utility grid
- **SILENSE (2016-1) (Ultra)Sound Interfaces and Low Energy iNtegrated SEnsors** machine-learning algorithms for key event detection by acoustics
- **I-MECH (2016-1) Intelligent Motion Control Platform for Smart Mechatronic Systems** provide augmented intelligence for wide range of cyber-physical systems having actively controlled moving elements
- **Productive4.0 (2016-2) Electronics and ICT as enabler for digital industry and optimized supply chain management covering the entire product lifecycle** predictive maintenance that integrates diverse data sets and uses complex deep learning algorithms such as neural networks;
- **R3-PowerUP (2016-2) 300mm Pilot Line for Smart Power and Power Discretes** on-line predictive model components, with special reference to new algorithms that leverage machine-learning theories
- **SCOTT (2016-2) Secure COnnected Trustable Things** build advanced cybersecurity defences using a combination of threat intelligence, big data analytics, machine learning and security experts
- **TAKEMI5 (2016-2) Technology Advances and Key Enablers for Module Integration for 5 nm** Machine Learning Algorithms executed upon Big Data Infrastructures enable Patterning validation for ULSI

Using Artificial Intelligence tec

- **iDev40 (2017-1) Integrated Development 4.0** Methods and Tools Enabling AI and Machine Learning (ML) in the ECS Domain
- **PRYSTINE (2017-2) Programmable Systems for Intelligence in Automobiles** Dependable embedded control by co-integration of signal processing and AI approaches for FUSION
- **COMP4DRONES (2018-2) Framework of key enabling technologies for safe and autonomous drones' applications** will develop an on-board high-performance computing architecture where flightplanning algorithms, such as embedded artificial intelligence algorithms, can run in a safe manner
- **MADEin4 (2018-1) Metrology Advances for Digitized ECS industry 4.0** CPS development which combines Machine Learning (ML) of design (EDA) and metrology data for predictive diagnostics of the process and tools performances
- **iRel40 (2019-1) Intelligent Reliability 4.0** AI and ML methods for simulation of reliability of components and systems
- **NextPerception (2019-2) NextPerception - Next generation smart perception sensors and distributed intelligence for proactive human monitoring in health, wellbeing, and automotive systems** bring perception sensing technologies like Radar, LiDAR and Time of Flight cameras to the next level, enhancing their features to allow for more accurate detection of human behaviour and physiological parameters.
- **Progressus (2019-2) Highly efficient and trustworthy components and systems for the next generation energy supply infrastructure** extend the cooperative energy management scheme beyond individual microgrids to groups of prosumers by: i) developing machine-learning methods that are mainly based on reinforcement learning procedures in order to enhance the effectiveness of the energy management scheme, as well as machine-learning algorithms which predict time/amount/duration/available current buffer and communicate this data to upper level grids; ii) incorporating the blockchain approach in terms of smart contracts for the microgrid participants, in order to enhance the energy exchange procedure and add security aspects; iv) moreover, the developed algorithms will be integrated into a platform that will be developed in order to control the operation of the microgrid

Using Artificial Intelligence tec

- **Energy ECS (2020-1) Smart and secure energy solutions for future mobility** Develop and implement optimized energy management algorithms to support penetration of renewable energies and overall electrification; Develop microgrid fleet management and identify feasible locations for microgrids; Develop a Smart Energy Grid Digital Twin
- **AIDOaRt (2020-2) AI-augmented automation for efficient DevOps, a model-based framework for continuous development At RunTime in cyber-physical systems** focusing on AI-augmented automation supporting modeling, coding, testing, and monitoring as part of a continuous development in Cyber-Physical Systems
- **AI-TWILIGHT (2020-2) AI powered Digital twin for lighting infrastructure in the context of front-end Industry 4.0** To understand, develop and implement new predictive models for ageing, leveraging on AI techniques; Make use of CPS approaches: include sensors, edge computing and IoT as well as new data processing technologies not yet used in LED life-time estimations to provide data for SSL products' predictive maintenance proposes, especially for use in mission critical solid-state lighting application tasks

Enabling Artificial Intelligence tec

- **OCEAN12 (2017-1) Opportunity to Carry European Autonomous driviNg further with FDSOI technology up to 12nm node** technology domain of artificial intelligence we are especially interested in the potential of the FD-SOI chip technology for deep learning / deep neural network algorithms
- **WAKeMeUP (2017-1) to** investigate the feasibility of PCRAM for for neuromorphic computing
- **CPS4EU (2018-1)** investigates building blocks for CPS computing for 1. High performance embedded computing, 2. AI computing, 3. Vision computing; that will be developed by European technology providers and will include the required components and subsystems with respect to hardware and software
- **AI4DI (2018-2) Artificial Intelligence for Digitizing Industry** Europe has a lack of intellectual property in integrating artificial intelligence (AI) into digital applications. nvestigate, develop and apply AI tools for change detection and distributed system intelligence, and develop hardware and software modules as internet of things (IoT) devices for sensing, actuating, and connectivity processing
- **TEMPO (2018-2) Technology and hardware for neuromorphic computing** broadens the applicability of integrated neuromorphic hardware by improving energy efficiency with emerging memory technologies
- **BEYOND5 (2019-1) Building the fully European supplY chain on RFSOI, enabling New RF Domains for Sensing, Communication, 5G and beyond** implement a cost-efficient system with edge signal processing and deep learning algorithms to allow for higher sensor performance at lowest cost, thanks to FDSOI enabling mm-Wave RF and AI logic merger on a single chip
- **InSecTT (2019-1) 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, creating trust in AI-based intelligent systems and solutions.
- **ANDANTE (2019-2) Ai for New Devices And Technologies at the Edge** hardware platforms to build strong hardware / software platforms for artificial neural networks (ANN) and spiking neural networks (SNN) as a basis for future products in the Edge IoT domain, combining extreme power efficiency with robust neuromorphic computing capabilities and demonstrate them in key application areas

Enabling Artificial Intelligence tec

- **BRAINE (2019-2-SP2) Big data pRocessing and Artificial Intelligence at the Network Edge** development of the Edge framework and specifically energy-efficient hardware and AI-empowered software systems, capable of processing Big Data at the Edge, performing AI functions, supporting security, data privacy and sovereignty
- **FRACTAL (2019-2-SP2) A Cognitive Fractal and Secure EDGE based on an unique Open-Safe-Reliable-Low Power Hardware Platform Node** create a reliable computing platform node, a Cognitive Edge, under industry standards that will be the building block of scalable decentralized Internet of Things (ranging from Smart Low-Energy Computing Systems to High-Performance Computing Edge Nodes).
- **StorAIge (2020-1) Embedded storage elements on next MCU generation ready for AI on the edge** prototyping of high performance, ultra low-power and secured & safety System on Chip (SoC) solutions enabling competitive AI for Edge applications; new design methodologies and tools to facilitate the exploitation of these advanced technology nodes, particularly for high performance microcontrollers (MCUs) having AI capabilities
- **TRANSACT (2020-1) Transform safety-critical cyber-physical systems into distributed solutions for end-users and partners** Extend the existing edge/cloud technologies in order to support safety-critical CPS and enable a continuous deployment of functions over the device-edge-cloud continuum; Integrate AI based services and data analytics services into safety-critical CPS;
- **AI4CSM (2020-2) Automotive Intelligence for/at Connected Shared Mobility** Design silicon for deterministic low latency and build AI-accelerators for decision and learning; Solve complexity by trustable AI in functional integrated systems; AI-Enabled Perception and Sensor Fusion Platforms; AI-Based Methods, Simulation and Virtualization
- **DAIS (2020-2) Distributed Artificial Intelligent Systems** will research and deliver distributed artificial intelligent systems; by solving the problems of running existing AI algorithms on distributed edge devices that are designed based on three European principles; Develop Edge AI Electronic Components and software that are self-organizing, energy efficient and private by design; Securely Integrate Edge components to cloud and fog;
- **IMOCO4.E (2020-2) Intelligent Motion Control under Industry 4.E** Software and Hardware building blocks (BBs), edge-to-cloud distributed and featuring standardized interfaces, will be developed to deliver a complete IMOCO4.E reference framework; will provide hardware, software and methodology for fast data acquisition and pre-processing for further AI-based processing

HW components for IoT: low power device technology, RF capabilities, low cost sensors,

- **PRIME (2015-1) Ultra-Low PoweR technologIes and MEmory architectures for IoT** Develop the key components to enable a flexible design ecosystem for ultra-low-power technology platforms enabling IoT products. This includes IP as well as design flow development. Design energy-adaptive hardware platforms for IoT servers as well as high performance and ultra-low power sensor nodes to efficiently provide smart mobility, smart society, smart energy, smart health, and smart production applications with various requirements. Implementation of secured IPv6 protocol in wireless, battery-less sensors networks
- **REFERENCE (2015-1) Rf Engineered substrates to FostER fEm performance** Cellular / Iot : 4G+ RFSOI FEM module
- **EnSO (2015-2) Energy for Smart Objects** thin film micro battery for connected products
- **IoSense (2015-2) Flexible FE/BE Sensor Pilot Line for the Internet of Everything** lower the cost of the sensors as they form the highest cost factor in an IoT node
- **CONNECT (2016-1) Innovative smart components, modules and appliances for a truly connected, efficient and secure smart grid.** IoT facilitates tracking of real-time energy consumption and demand via deployment of millions of sensors capable of measuring, monitoring and communicating energy data that can be used to implement a self-arranging grid, which can automatically undertake decisions and self-monitor itself
- **BEYOND5 (2019-1) Building the fully European supplY chain on RFSOI, enabling New RF Domains for Sensing, Communication, 5G and beyond** NB IoT: since the target is to integrate cellular RF FEM and analog transceivers in the same IC (digital section being limited since the modem remains external), 65 nm PD SOI technology is viewed as the best cost/performance compromise
- **CHARM (2019-1) Challenging environments tolerant Smart systems for IoT and AI** grasping the digitalization and IoT related opportunities can be limited by the harsh environmental conditions of the manufacturing process and/or end use environment, together with the requirement for small form factors, the simultaneous combination of severe thermal, mechanical and chemical stress is difficult for components and systems intended for current IoT systems. CHARM aims to contribute in solving this issue.

HW components for IoT: low power device technology, RF capabilities, low cost sensors,

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- **NextPerception (2019-2) NextPerception - Next generation smart perception sensors and distributed intelligence for proactive human monitoring in health, wellbeing, and automotive systems** NextPerception will integrate existing standards from IoT platforms for the interoperability between the smart components of the system and extend standards where they do not cater for the needs of distributed intelligence
- **FRACTAL (2019-2-SP2) A Cognitive Fractal and Secure EDGE based on an unique Open-Safe-Reliable-Low Power Hardware Platform Node** create a reliable computing platform node, a Cognitive Edge, under industry standards that will be the building block of scalable decentralized Internet of Things (ranging from Smart Low-Energy Computing Systems to High-Performance Computing Edge Nodes).

Internet of Things solutions

- **SemI40 (2015-2) Power Semiconductor and Electronics Manufacturing 4.0** improve fab digitalization and virtualization, and enable automation systems for agile distributed production
- **I-MECH (2016-1) Intelligent Motion Control Platform for Smart Mechatronic Systems** middleware and software gateway for development of IoT solutons.
- **Productive4.0 (2016-2) Electronics and ICT as enabler for digital industry and optimized supply chain management covering the entire product lifecycle** Developing a software infrastructure for IoT enabled smart mechatronic production components
- **MADEin4 (2018-1) Metrology Advances for Digitized ECS industry 4.0** machine learning metrology characterisations vectors training and verification generic flow; IIoT architectures for the Equipment and Quality on production lines;
- **Energy ECS (2020-1) Smart and secure energy solutions for future mobility** Development of a Multi-source Energy harvesting based IoT module;
- **AI-TWILIGHT (2020-2) AI powered Digital twin for lighting infrastructure in the context of front-end Industry 4.0** Make use of CPS approaches: include sensors, edge computing and IoT as well as new data processing technologies not yet used in LED life-time estimations to provide data for SSL products' predictive maintenance proposes, especially for use in mission critical solid-state lighting application tasks

SW components for IoT: secure

- **SafeCop (2015-1) Safe Cooperating Cyber-Physical Systems using Wireless Communication** integration of heterogeneous CPS that will represent a milestone towards building the future Internet of Things (IoT) with increased security and safety
- **SCOTT (2016-2) Secure COnnected Trustable Things** creating trust in wireless solutions and increasing their social acceptance are major challenges to achieve the full potential of the Internet of Things (IoT)
- **InSecTT (2019-1) 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, creating trust in AI-based intelligent systems and solutions.

- **Arrowhead Tools (2018-1) Arrowhead Tools for Engineering of Digitalisation Solutions** engineering tools that integrate existing automation and digitalisation engineering procedures and tools with these new IoT- and SoS-based automation/digitalisation technologies; Engineering cost reduction by 20-50% for a wide range of IoT and SoS automation/digitalisation solutions.

Enabling Edge computing

- **3CCar (2014-1) Integrated Components for Complexity Control in affordable electrified cars** develop a future proof highly integrated central computing unit (CCU), referred to as domain controller for current applications
- **SCOTT (2016-2) Secure COnnected Trustable Things** will cover solutions for distributed cloud integration with computing as close as possible to the sensors and actuators. Privacy-aware edge computing and the use of measurable means to assess system's security will provide protection of end-user's privacy and will lower chances of success of potential attacks. Distributing security-sensitive data between different components of the system makes it more resilient to potential attacks or malfunction.
- **AFarCloud (2017-2) Aggregate Farming in the Cloud** support a decision-support system that will facilitate the realization of the Edge/Fog computing concepts
- **Prystine (2017-2)** Sensor fusion HW/SW platform
- **CPS4EU (2018-1) Cyber Physical Systems for Europe** investigates building blocks for CPS computing for 1. High performance embedded computing, 2. AI computing, 3. Vision computing; that will be developed by European technology providers and will include the required components and subsystems with respect to hardware and software
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- **NextPerception (2019-2) NextPerception - Next generation smart perception sensors and distributed intelligence for proactive human monitoring in health, wellbeing, and automotive systems** Distributed intelligence in the edge and cloud subsequently allows for abstracting sensed data to higher levels of information, perform predictions and eventually provide support for decision making
- **BRAINE (2019-2-SP2) Big data pRocessing and Artificial Intelligence at the Network Edge** development of the Edge framework and specifically energy-efficient hardware and AI-empowered software systems
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Enabling Edge computing

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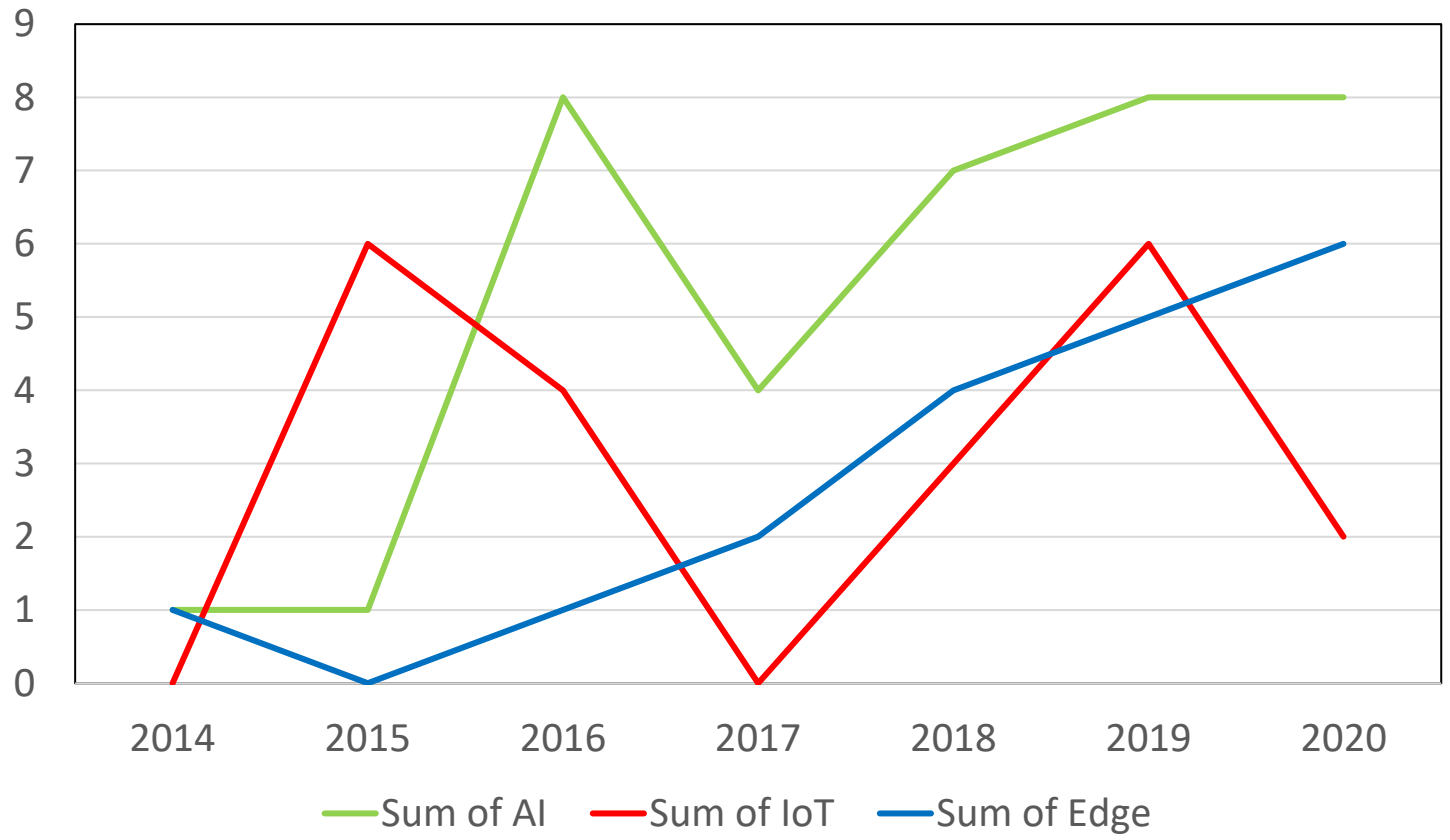
- **DAIS (2020-2) Distributed Artificial Intelligent Systems** will research and deliver distributed artificial intelligent systems. It will not research new algorithms, as such, but solves the problems of running existing algorithms on these vastly distributed edge devices that are designed based on these three European principles Develop Edge AI Electronic Components in hardware that are self-organizing, energy efficient and private by design; Develop Edge AI software that is self-organizing, energy efficient and private by design; Securely Integrate Edge components to cloud and fog

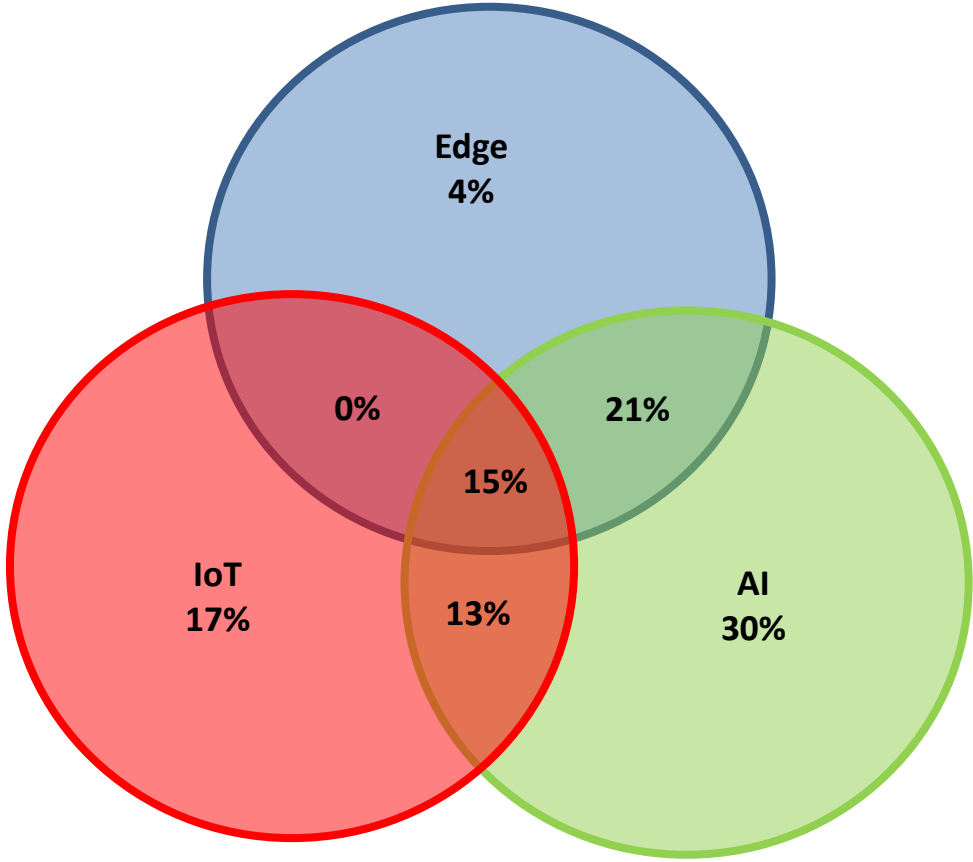
Conclusions

- Overlap in topics, evolution (see next slide)
- Mostly for industrial, mobility and energy applications
- Artificial Intelligence
  - 40% of the projects have an AI component
  - includes machine learning, embedded intelligence, deep learning, neuromorphic, ...
  - half of the projects use AI technologies to achieve their objectives/results the other half enable AI technologies as part of their objectives/results
  - but shift from using AI technology at the begin of ECSEL towards enabling AI technology at the end of the programme
- Internet of Things
  - 23% of the projects have an IoT component
  - 52% target HW components for IoT; 28% solutions compatible with IoT and 20% SW for IoT
  - focus on Industrial IoT
- enabling Edge computing
  - 21% of the projects have an Edge computing component
  - HW and SW developments, integration with communication systems (IoT)
- Years 2014 and 2017 low number of projects on those subjects
- Some projects were left out because they do not refer directly to the topics though they could bring valuable results for those fields.

Projects



overlapping categories



47 projects out of 92 (51%)