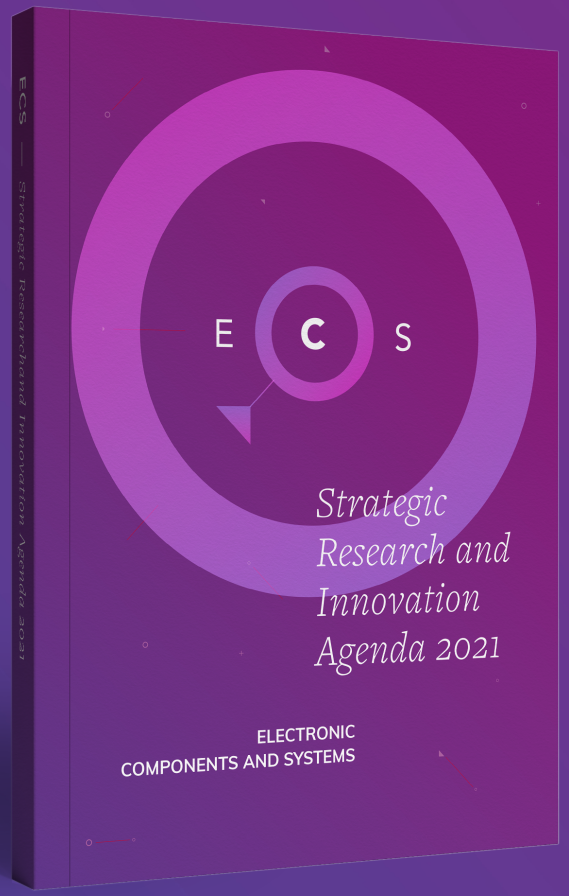

E C S

Electronic Components and Systems

SW in ECS-based digitization

Overview and initial priority settings

Paolo Azzoni
Head of EU Technology Programmes
Eurotech Group

Online meeting, 2021/05/04

ECS-based digitization

The digital transformation has been and will remain a key factor for global economy, and digital technologies, adopted as an inherent element of the business model, are the key factors for market success.

The ECS value network covers a significant part of digitization,

- a non-linear network of complex relations between heterogeneous stakeholders,
- continuously evolving, depending on the technology and market trends, …
- and providing the key digital technologies to:
  - connect the physical world with the digital world,
  - smartly process the collected information,
  - ensure seamless connectivity of both single devices and large distributed infrastructures,
  - automate industrial and organizational processes,
  - create new business models.

SW in ECS-based digitization

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Software is one of these key enabling technologies,

- with a presence in almost all the levels of the ECS value network,
- designed, developed and adopted by almost all the stakeholders,
- with a key role to support the entire life-cycle of ECS products and their applications.

The software market in Europe has great potentialities and fast-growing revenues, playing a critical role for fully-integrated systems, systems of systems and vertical applications, where the market is expected to grow tenfold by 2025*.

To unleash this potential, it is important to understand:

- where software is positioned in the ECS value network,
- what is the nature of software and its role,
- where to focalise research efforts to maximise the result and impact.

*Embedded Intelligence: Trends and Challenges - A Study by Advancy, Commissioned by ARTEMIS Industry Association, March 2019.

SW categories in the ECS value network

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MAIN SOFTWARE CATEGORIES

1 Application independent

- Software in foundational technical layers
  - Stack of the digitization solutions
- And/or in cross-sectional technologies
  - At various levels of abstraction
  - AI, Edge computing, IoT, security, connectivity, …
- E.g.: firmware up to OS, embedded virtual solution, containers, AI algorithms, edge computing platforms, IoT frameworks, …

2 Application-specific

- An adaptation, customization, extension of the previous category
- Or specifically conceived/developed for a vertical
- Typically, not reusable in other contexts
- But nevertheless, fundamental for the application
- E.g. : vertical business logic, AI algorithms for a specific vertical, the user application, HMI, …

3 SW for engineering and life-cycle support

- Engineering process automation
- Continuous and agile engineering
- Hardware & software codesign, …
- Support the product life cycle (including auto-test, auto-deploy, auto-patch, etc.)
- E.g. : EDA SW, IDE, design and development toolchains, test/debug suites, …

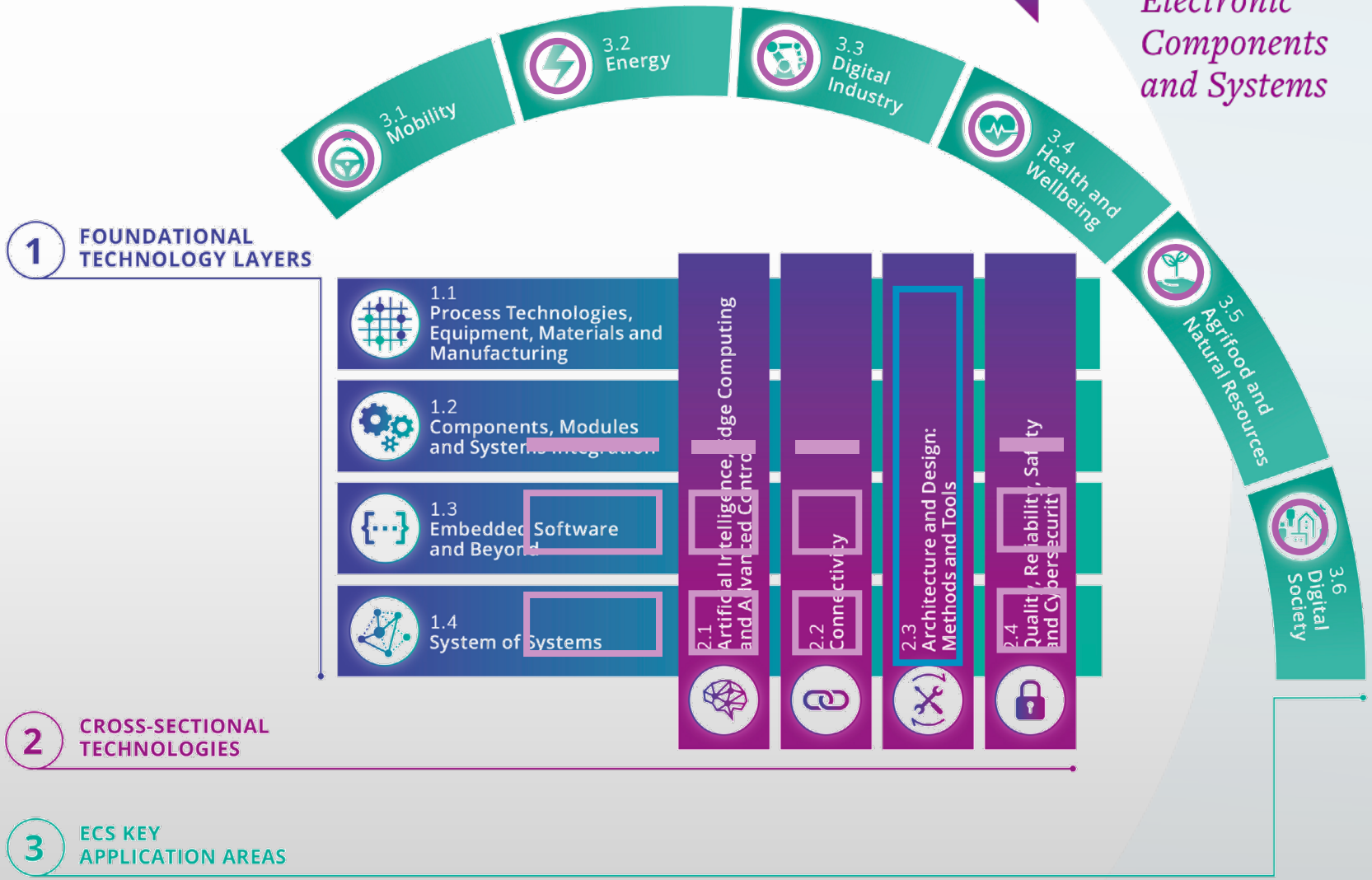
Software in the ECS- SRIA

Electronic Components and Systems

1 Application independent

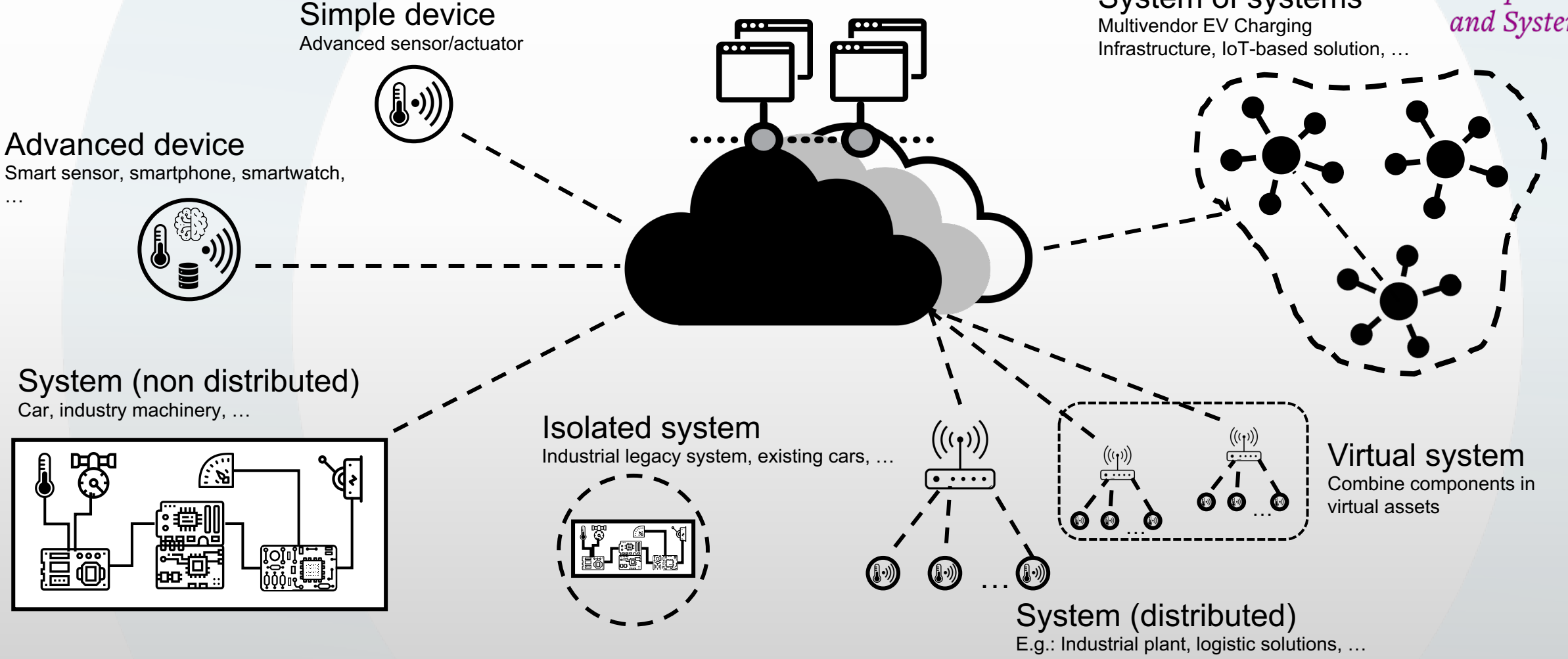
2 Application specific

3 SW for engineering and life-cycle support



ECS-based scenarios:
some examples

Electronic Components and Systems

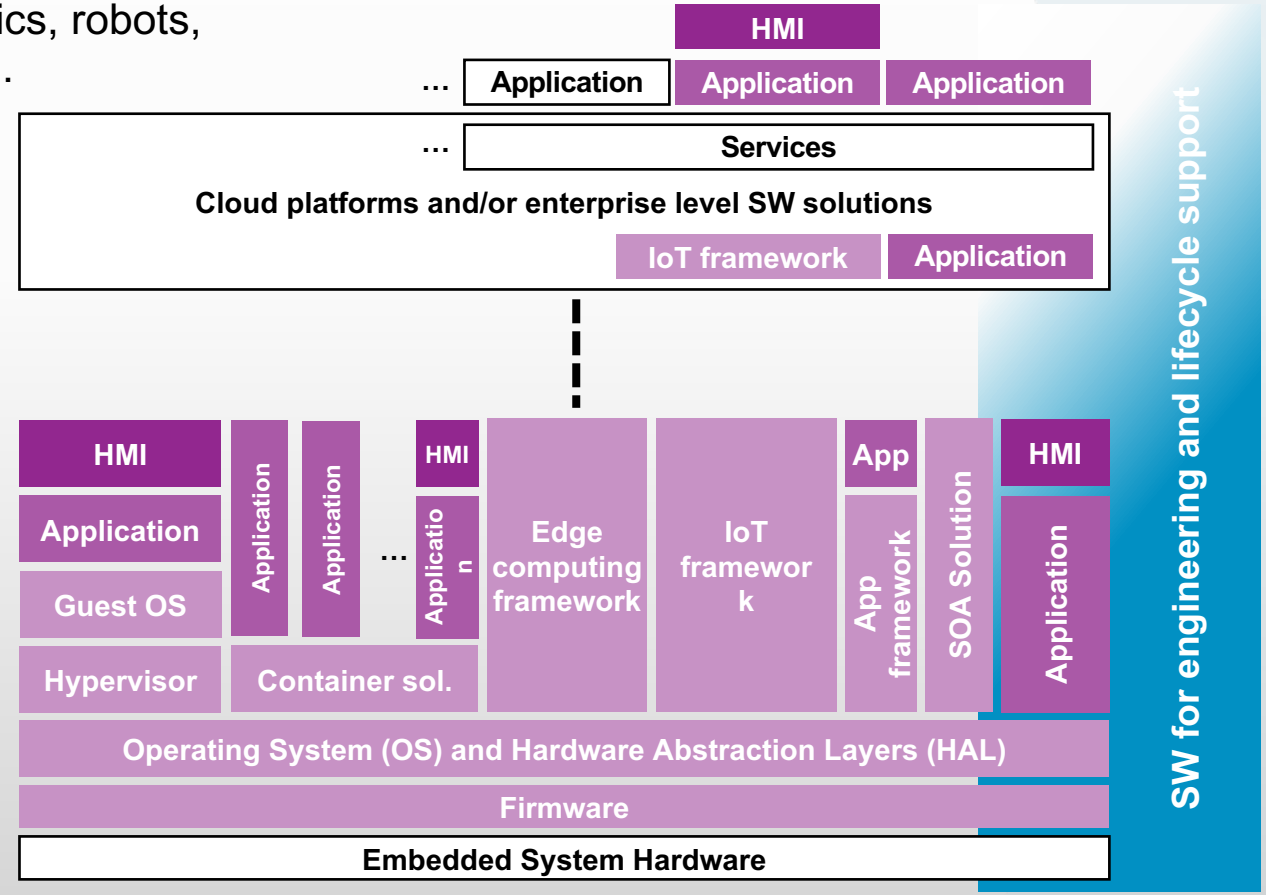


Embedded system example

Software in embedded systems:

- Conceived for limited resources devices
- We find ES SW in industrial equipment, car electronics, robots, telephones, toys, set-top boxes, smart-watches, etc..

- Firmware
- Operating systems
- Hardware abstraction layers and drivers
- Containerization solutions
- Embedded virtualization solutions
- Micro-service or SOA solutions
- Edge/distributed computing, IoT platforms/frameworks
- Application frameworks
- Embedded applications (not necessary for the final user)
- User interfaces (HMI)
- Cloud platform/enterprise level platforms
- Cloud/enterprise level services
- Cloud application/enterprise level applications
- SW for engineering and lifecycle support



Setting KDT priorities

Electronic Components and Systems

EU strategic markets

Focalization on strategic market areas for the European economy. See the analysis provided by the ECS-SRIA Synopsys, the Advancy report and the ECS-SRIA.

EU Commission

Coordinate and align the various initiatives. Harmonize the member states priorities. Ensuring continuity and full coverage of digitization, avoiding unnecessary overlapping and fragmentation, and guaranteeing diversity.

Linked initiatives

EU initiatives contributing to the ECS value network and/or complementary to the ECS value net. Contribute to continuity, avoid duplication and reduce fragmentation.

Member states

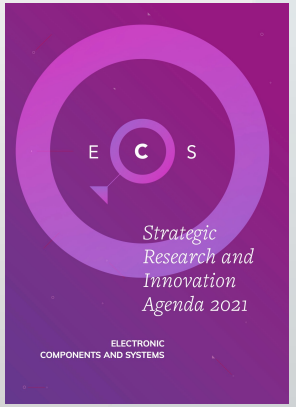
Define strategies and objectives, leading to national priorities, integrated with national programs. Find synergies and cooperation to define common priorities.

ECS community

Full visibility and control on the digitization process, ECS value network and associated markets. Strongly active in research and innovation, monitoring and defining technological trends, identifying challenges, studying application areas, etc.

Reference documents:

- ECS-SRIA Synopsys
- ECS-SRIA
- KDT Partnership Proposal



Priorities for the KDT

Electronic Components and Systems

Foundational and cross technology priorities

- Embedded intelligence
- Platforms for edge computing, IoT and SoS integration
- Interoperability
- End-to-end trustworthiness
- Engineering support

Application-specific priorities

- Mobility
- Digital industry
- Energy
- Health and wellbeing
- Agrifood and natural resources
- Digital society

Embedded intelligence

ECS must be provided with a certain level of intelligence and autonomy:

- to better manage their complexity,
- to provide novel advanced functionalities,
- support the evolutionary nature of systems and SoS,
- improve the interaction with humans,
- enable vertical applications,
- improve sustainability and resilience of ECS and of the associated value network.

PRIORITY

Develop AI-distributed solutions to support edge computing, IoT and SoS.

Distributed AI requires less access to central resources, such as incremental learning done at the edge, or federated learning performed by a set of edge devices. Development of advanced control concepts for distributed (multi-agent) systems that also take uncertainties in communication and structure (topology) into account.

PRIORITY

Managing the increasing complexity of systems to achieve higher automation.

E.g. exploit AI to improve interoperability of systems, facilitate software modularity, adoption of standards and common interfaces, complexity management in systems and SoS.

PRIORITY

Increase trustworthiness in computing systems based on AI.

E.g. safety and cybersecurity of AI-based system, modular (pre-)certification AI, certified data-sets, …

PRIORITY

Software solutions to support AI on the edge and on deep edge.

Adding intelligence close to the sensors and/or to the data sources (IoT), and to integrate the components in a form factor that perfectly suits their applications. A device using edge AI can process data it has collected and subsequently take decisions independently. Edge AI extends embedded computing and has a positive impact on digitisation sustainability.

PRIORITY

Support sustainability with AI-based software solutions.

E.g. AI-based energy management; develop the concept of 2nd life to increase the lifespan of computing devices and systems; self-X (adaptation, reconfiguration, ...) for embedded systems; improve SW upgradability; develop open source software and sustainable training data-sets and algorithms.

Integration and orchestration platforms

Electronic Components and Systems

Digitization is built on physical-digital mapping, supported by an endless choice of excellent hardware devices, but requires their integration / orchestration in a distributed, connected, evolvable, upgradable, interoperable, trustable, … ecosystem.

Platforms contribute to the existence of the digitization value network, creating an ecosystem of companies, firms, technologies, standard, vertical domains, … and facilitate the market entry for SMEs and companies approaching digitization.

Platforms address the market segment of the ECS value chain that is expected to grow tenfold by 2025.

PRIORITY

Architectures for edge computing, IoT and SoS, supported by appropriate design and architecting tools.

E.g. Open, interoperable, trustworthy and robust architectures capable of supporting a wide range of solutions in diverse field of applications. Architecting SoS is fundamentally different from architecting a single embedded system. Platforms implement these architectures.

PRIORITY

Open edge computing, IoT and SoS platforms.

Platforms provide infrastructure integration, remote man., fleet man., provisioning, infrastructure abstraction, APIs, SOA functionalities. Open platforms should ensure information security management, scalability, engineering efficiency, real-time performance, robust control, QoS and distributed intelligence.

PRIORITY

Support complexity, evolvability, heterogeneity and diversity in the integration and orchestration process.

Efficient and flexible engineering processes, supporting the complete engineering process along the system's lifecycle. Support for key automation requirements. Automated engineering, testing validation and verification (TV&V).

PRIORITY

Support dynamic composability of edge computing, IoT and SoS, and provide adequate countermeasures.

Composability generates new uncertain properties, functionalities and behaviours. It affects interoperability, scalability, availability, resilience to failures, security, etc.

Interoperability

Electronic Components and Systems

The digitization continuum is not such if the components of the continuum are not interoperable.

Behind every component there is one or more stakeholder, hence interoperability of components translates in stakeholders interaction.

It is difficult that a healthy and productive digitization value network exists and flourishes without interoperability.

Software (and standards) plays a fundamental role for interoperability.

PRIORITY

Integration platforms interoperability

E.g. interoperability with legacy technology, with existing and emerging IoT and SoS technologies and platforms; data and service level interoperability, …

PRIORITY

IoT and SoS interoperability

Technologies and solutions enabling instant and seamless understanding of data/information exchanged within and between networked and distributed systems; interoperability-by-design at the component, semantic and application levels.

PRIORITY

Trust by interoperability

Interoperability allows to share between the parties, the used processes, the security levels, the quality of the information, who are the parties, with whom of them the information are shared, ...

PRIORITY

Autonomous interoperability for communication protocol, data encoding, security and information semantics.

E.g. semantics interoperability, autonomous information translations, M2M understanding, …

PRIORITY

AI interoperability

The reference architectures for future AI-based systems need interoperability and shared to support the integration into various applications across industrial sectors.

PRIORITY

Engineering process interoperability for cost-effective engineering and operation.

Technologies and solutions enabling interoperability between tools and toolchains for engineering process automation.

End-to-end trustworthiness

Electronic Components and Systems

The edge to cloud continuum is not only an infrastructural (HW&SW) continuum,

- it is also a trustworthiness continuum,
- covering the digitization value network end-to-end
- including the HW/SW stack inside the devices,
- across the entire life-cycle.

Digitization needs a trustworthiness continuum, covering security, safety, privacy, reliability, explainability, etc., depending on the specific technology and vertical domain.

The absence of trust in digitization represents a considerable societal and business barrier.

PRIORITY

Ensuring end-2-end cyber-security, safety and privacy of edge computing, IoT and SoS.

E.g. e-2-e platform-based trust solution ensuring security, safety, reliability, privacy, … of IoT devices, communications, distributed infrastructures, …

PRIORITY

Ensuring quality and reliability through design for reliability and systems prognostics health management.

E.g. digital twin models for reliability assessment across supply chain; solutions for self-monitoring, self-assessment, and resilience concepts for automated and autonomous systems based on the merger of PoF, data science, and machine learning for safe failure prevention.

PRIORITY

Privacy & human Interaction

E.g. privacy-by-design, GDPR compliancy, privacy in AI interaction, HMI for trusted operations and AI-based applications.

PRIORITY

Reliable software on new computing architectures and platforms.

E.g. code coverage of reliability tooling and porting, simulation and mock-up based approaches for handling concurrency, embedding reliability on a software system architecture level.

PRIORITY

Testing of SW against unexpected uses.

E.g. solutions based on simulations and digital twin

PRIORITY

Trust management in complex systems comprising distributed and heterogeneous components.

E.g. distributed and decentralized trust mechanisms, distributed ledger; solutions to manage unpredictable behaviours impacting on trustworthiness; M2M trust management; self-adaptive trust; …

Engineering and lifecycle support

Electronic Components and Systems

Engineering and lifecycle support are key factors for industrial competitiveness and

- to consolidate research results in products,
- for their sustainable evolution,
- for the existence of a healthy, sustainable and resilient value network and a successful market,
- for EU strategic autonomy, industry competitiveness and sustainable labor market,
- to enable professional training and education.

The complexity of digitization require more engineering support than "conventional" products.

PRIORITY

Frameworks for engineering automation and continuous life cycle support, to handle connected, smart, autonomous, evolvable systems and SoS.

E.g. AGILE and virtual engineering, DevOps, lifecycle aware holistic design flows, inclusion of sustainability in verification and validation processes, automated validation and certification, electronics design automation, legacy rejuvenation, design for X (test, evolvability, diagnostics, adaptability etc.), …

PRIORITY

Managing new functionalities in evolving, safe, secure, and trustable systems and SoS

E.g. modelling techniques for new functionalities, design and V&V methods for ECS (including AI based systems) evolving during lifetime, energy-aware design methods, trust by design, …

PRIORITY

Managing complexity, in terms of capabilities, properties, operative environment, tasks, dynamicity, reconfigurability, composability, …

E.g. methods and tools to increase design efficiency. complexity reduction methods, tools for V&V and testing, methods and tools for advanced architectures, trust by design, systems modelling languages,

PRIORITY

Managing ECS diversity, with a multi-layered approach covering all the design hierarchy.

E.g. multi-objective design & optimisation of components and systems; modelling, analysis, design and test methods for heterogeneous systems; engineering support for multidisciplinarity; efficient modelling analysis and test, considering properties, physical effects and constraints

Application-specific priorities

Electronic Components and Systems

Mobility

Cars today run on code, increasing in complexity as higher levels of safety and security are required.

Embedded software platforms and tools for future connected, automated electrical shared mobility.

PRIORITIES

- **Shift to automated driving:** ADAS/AD control software (computing, machine learning, distributed control architectures, safe navigation), perception and sensing
- **Improve the level of electrification aiming at CO2 neutrality:** energy reductions, route planning, mechanical replacement, fast charging
- **Connected, upgradable and maintainable cars:** OTA upgrades, new services & feature, in-vehicle performance monitoring and predictive maintenance
- **Immersive experience:** interactive, graphically rich and customizable HMI
- **Engineering support:** development and test environment, methods and tools for verification, validation & certification of SW-defined ADAS/AD vehicles, functional safety assessment, continuous integration & deployment, continuous feedback of data, safety, security, reliability, … by design.

Energy

Our lives, our daily activities and the way we do business depend on sustainable energy supply and its efficient management.

Bring intelligence to the grid, for asset management, security, generation and demand management, from the grid edge.

PRIORITIES

- **SW solutions for smart & efficient management of energy generation, conversion, storage systems and grid integration.**
- **SW solutions for energy management, distribution & transmission, systems on-site or behind the meter. Integration of electricity, heating, cooling, and transport.**
- **Efficient community and regional energy management,** increasing the share of renewable generation, self-consumption and building optimization.
- **Energy system monitoring & control,** based on artificial intelligence & advanced communication techniques for cyber security and resilience energy system control, control of distributed generation and dispersed energy-storage devices.

Digital industry

Digitization continues to be regarded as a key enabler for the future success of European industry.

Improve industrial processes automation, sustainability, efficiency, safety, remote operations, training, …

PRIORITIES

- **SW solutions (incl. digital twins & VR) for responsive, smart and sustainable production,** to quickly react to changes, efficient work allocation, … improve use & reuse of the resources, real life cycle assessment, human in the loop, …
- **Artificial Intelligence,** for production, operations, maintenance, dynamic and autonomous management, asset monitoring, decision-making, … autonomous systems, industrial machines and robots
- **Industrial remote operations and teleoperation,** with fleet management, edge to cloud solutions, remote engineering, …
- **Collaborative product-service engineering, lifecycle engineering, training and simulation environment.**

Application-specific priorities (2)

Electronic Components and Systems

Health & wellbeing

P4 approach (predict, prevent, participate, personalize) is reshaping healthcare, another important center of gravity for digitization.

Embedded and distributed software solutions in the edge-to-cloud continuum to support both patients, medical personnel and health distributed infrastructures.

PRIORITIES

- **SW for patients:** electronic health record, e-prescribing, health improvement, personal emergency response systems, telemedicine, …
- **SW for medical personnel:** medical database, e-prescribing, telemedicine.
- **Medical diagnosis SW:** AI SW supporting data analysis and diagnosis generation, diagnosis app for patients (e.g. covid app).
- **Medical imaging software:** medical imaging and visualization software for processing MRI/CT/PET scans and designing 3D models.
- **Medical equipment management software:** manage and maintain in a secure, automatic and efficient way fleet of medical equipment in clinics.

Agrifood and natural resources

Planet Earth and its resources are humanity's most important treasures, to be conserved and protected.

Bring sensing, data analysis, intelligence, control to the entire agrifood and natural resources value chains.

PRIORITIES

- **Food security & safety:** IoT-based multi data source analysis, farms management systems, plant and herd health monitoring; AI-based food production analysis.
- **Environmental protection and sustainable production:** in-situ, real-time monitoring of soil nutrients and herbicides with AI support for fertilization strategies; digitization and monitoring of greenhouse impact of livestock; farm waste management.
- **Water resources**: distributed, society-inclusive solutions for water management, quality and consumption monitoring; fresh waters and hydrogeologic risks monitoring.
- **SW solutions for biodiversity restoration, ecosystems resilience, conservation and preservation.**

Digital society

We already live in a digital society, but digitalization is accelerating, and we need to be sure that it is for the benefit of all, is sustainable, inclusive and safe.

Software for individual inclusion, development and protection, towards the collective wellbeing of a resilient and sustainable society.

PRIORITIES

- **Maximize individual development and protection of citizens:** tools, training and connectivity for digital inclusion; online education; HMI & VR; embedded cobots, chatbots.
- **Safeguard the collective wellbeing and resilience of a society:** crowd management; responsible, explainable and trustworthy AI; SW platforms for surveillance, emergency & crisis response; homeland security and cybersecurity.
- **Contribute to environmental sustainability:** IoT and AI-based management of physical infrastructure, industrial areas, traffic and logistics; SW platforms for distributed digital Infrastructure management; mobile e-government and citizen support; resource monitoring.

Thank you for the attention.

“When digital transformation is done right, it’s like a caterpillar turning into a butterfly, but when done wrong, all you have is a really fast caterpillar.”

— George Westerman, MIT Sloan Initiative on the Digital Economy