Alliance for IoT and Edge Computing Innovation

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Advancing Edge IoT Technologies

AIOTI Strategic Research and Innovation Agenda

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AIOTI Strategic Research and Innovation Agenda

The AIOTI SRIA identifies technological development, key trends, issues, and challenges within different thematic areas related to next-generation IoT and edge computing advancements, while providing several selected research priorities over the 2023-2030 period.

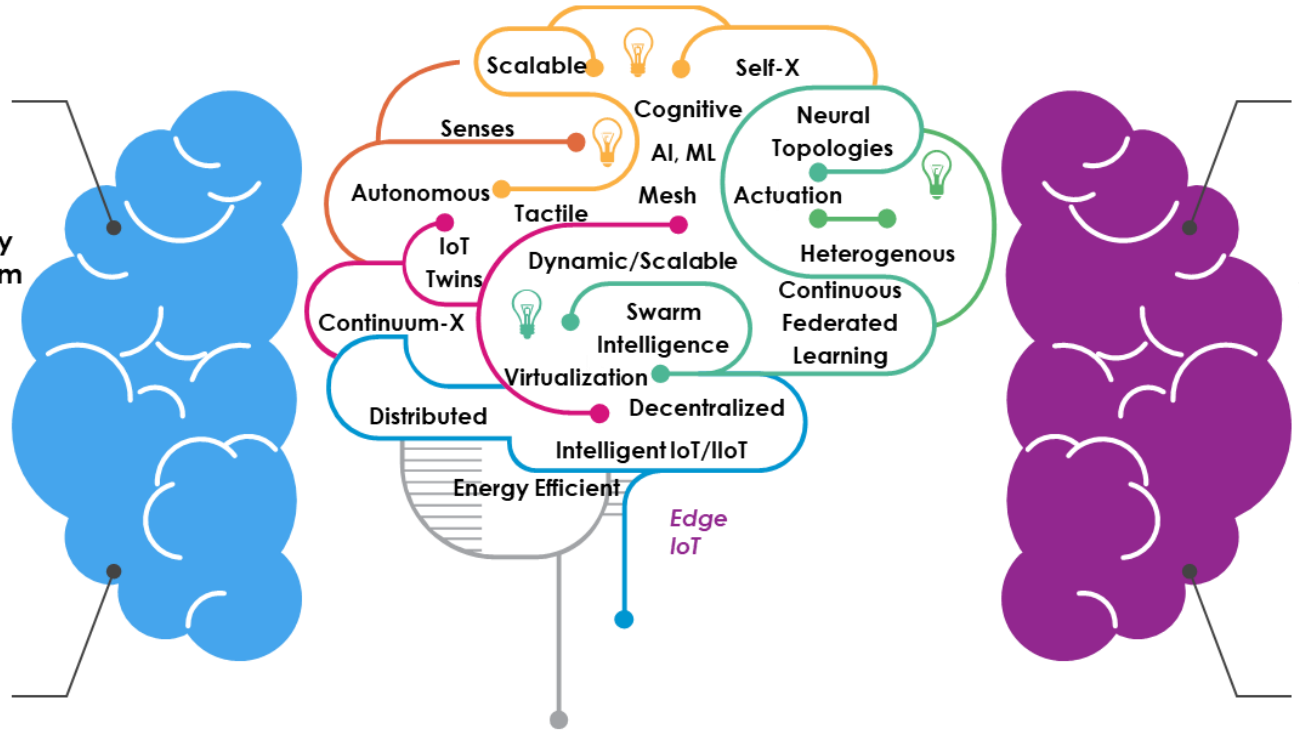
The vision for the AIOTI SRIA is to foster a dynamic IoT, and edge computing European ecosystem based on heterogeneous technology integration into digital value chains across several industrial sectors.

The AIOTI SRIA mission is to support, enhance and strengthen Europe's IoT and edge computing research and innovation capabilities to advance the digital and green transformation, based on sustainable and trustworthy technologies and applications development.

The AIOTI SRIA is designed to be application domain and funding programme agnostic and can be utilised as a foundation for different industrial vertical applications and as input to the various cooperative work programmes across Horizon Europe, Digital Europe and the European partnerships.

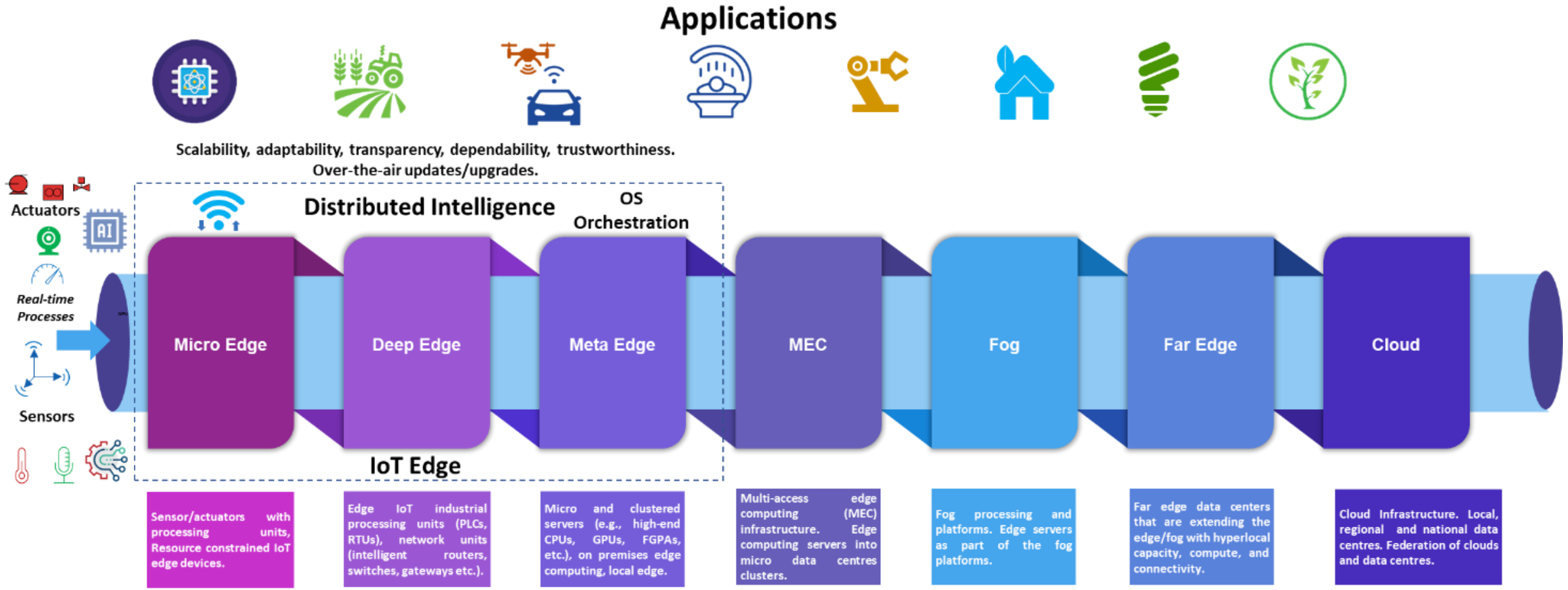
AIOTI SRIA

IoT and Edge Computing Granularity
IoT Edge and X-Continuum Paradigm
Intelligent Connectivity
Energy-Efficient IoT Edge Systems
Heterogeneous IoT Edge Mesh
IoT Digital Twins
IoT Swarm Systems
Internet of Things Senses

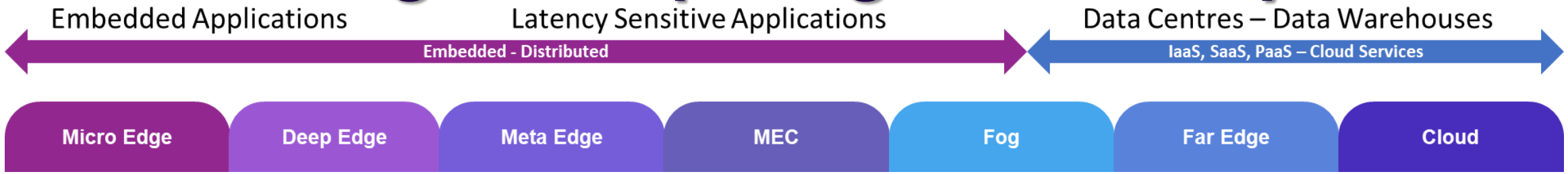


Decentralized and Distributed IoT Edge Systems
AI for IoT Edge Systems
OS and Autonomous Orchestration
Dynamic Programming Tools
Heterogenous Edge IoT Systems Integration
Edge IoT Cross-Sectorial Open Platforms
Edge IoT Verification, Validation and Testing
Edge IoT Trustworthiness and Dependability

IoT and Edge Computing Granularity



IoT and Edge Computing Granularity



- **Meta Edge:** Edge servers and clustered servers (e.g., high-end CPUs, GPUs, FGPAs), on premises edge computing servers, local edge servers, high performance embedded edge computing.
- **Deep Edge:** Edge IoT gateways and processing units, network computing units and intelligent controllers (e.g., PLCs, RTUs, DCS).
- **Micro Edge:** Edge IoT devices including sensing and actuating, connectivity, intelligent processing (e.g., CPUs, GPUs, TPUs). Resource and energy-constrained IoT and edge processing units.

- Micro-edge latency below 1 ms, range from mm to 15 m.
- Deep-edge latency below 2-5 ms, range up to 1 km.
- Meta-edge latency below 10 ms, range up to 50 km.
- MEC latency 10-5 ms, range up to 75 km.
- Fog latency 10-20 ms, range up to 100 km.
- Far-edge latency 20-50 ms, range up to 200 km.
- Cloud and data centres latency 50-100 ms, range up to 1000 km.

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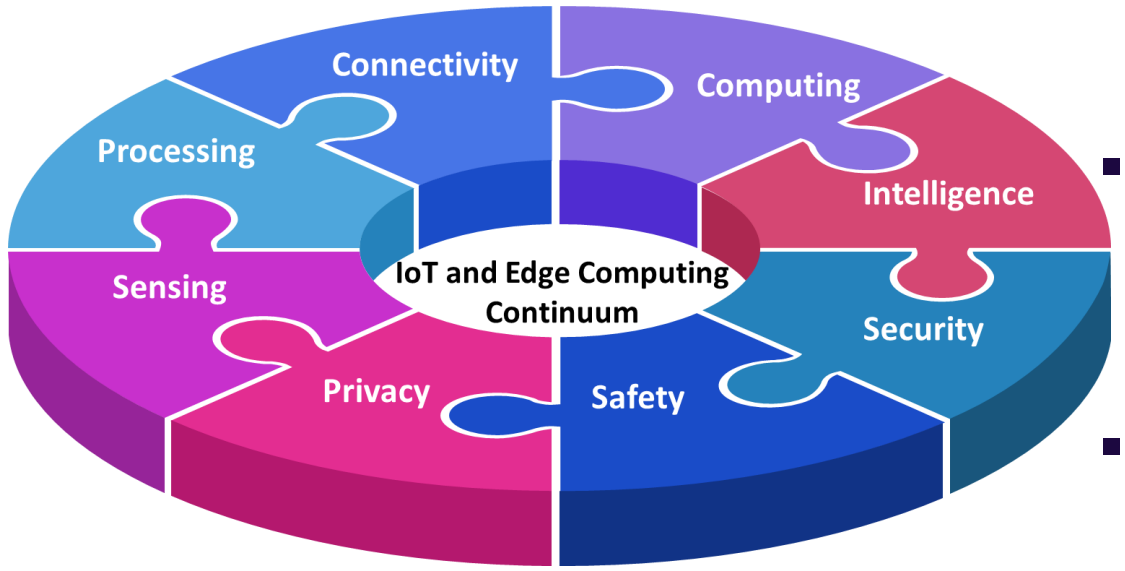
IoT Edge and X-Continuum Paradigm

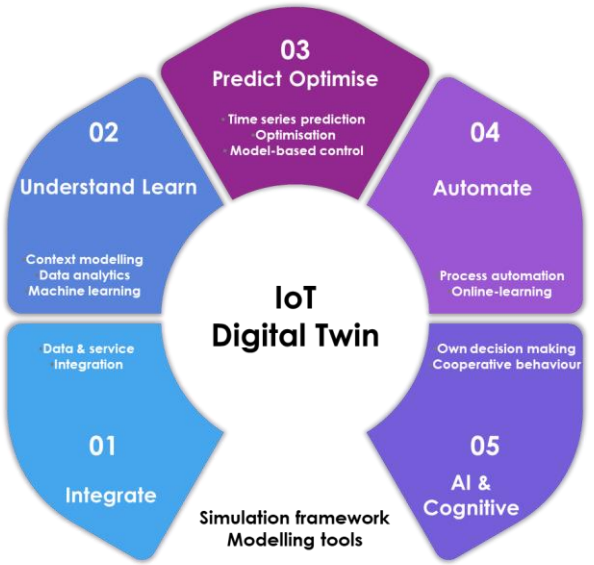


- Integrate E2E capabilities such as sensing, processing, connectivity, computing, storage, intelligence, security, safety, and privacy.
- Continuum of technologies across different layers (e.g., sensors, robots, HW and SW platforms, connectivity, gateways, edge processing, applications, AI, analytics)
- Continuum of intelligence and IoT edge capabilities.
- Continuum of IoT edge applications across vertical sectors and their seamless integration.

IoT Digital Twins, Modelling and Simulation

- Virtual representation of IoT devices mirroring the relevant dynamics, characteristics, critical components and important properties of an original physical object throughout its life cycle. Real-time update based on reliable multi-sense wireless sensing, cyber-physical interaction and reliable wireless control over interaction points with embedded wireless devices.
- Technique for mesh and multi point over the air (OTA) updates and addition of new functionalities.
- Simulation and modeling tools, for large scale of real-time, robust and seamless interactions among, IoT digital twins, humans, robots, machines and environments.

Intelligent IoT twins advance process automation by providing decision-making based on actual and simulated scenarios by implementing cooperative behaviour based on the information exchanged in real-time with the edge IoT physical systems.



IoT digital twins implementation collects real-world data about edge IoT devices or systems as inputs. It produces outputs simulations or predictions of how that edge IoT physical devices or systems are affected by those inputs

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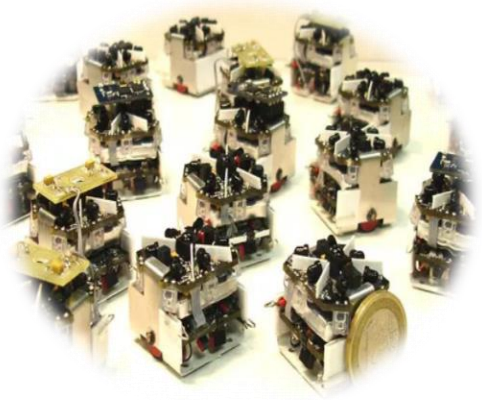
IoT Swarm Systems

- Swarm intelligence focuses on the IoT system collective behaviour and is inspired by social swarms in nature such as bird flocks, ant colonies and honeybees.
- Interplay between Edge IoT, swarm computing and AI
- Technology for integrating IoT sensing intelligence in agents (AI) and in interactions (collective intelligence)
- Swarm-designed security and IoT devices behaviour patterns
- Modelling and simulation of IoT swarm ecological classes and ecosystems and integration with IoT digital twin technologies
- Swarm intelligence algorithms for edge-based IoT/IIoT



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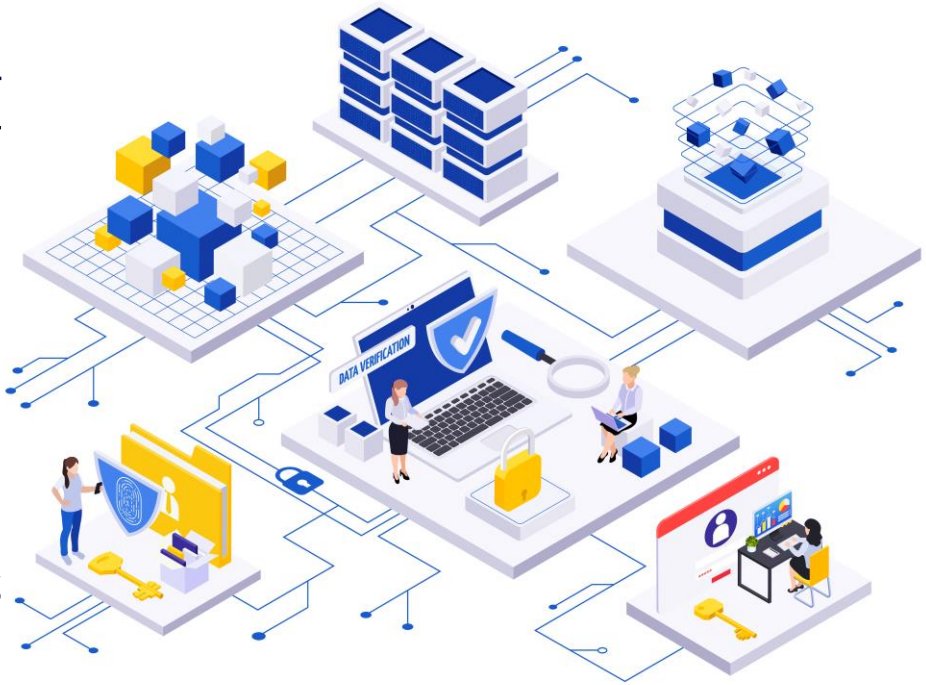
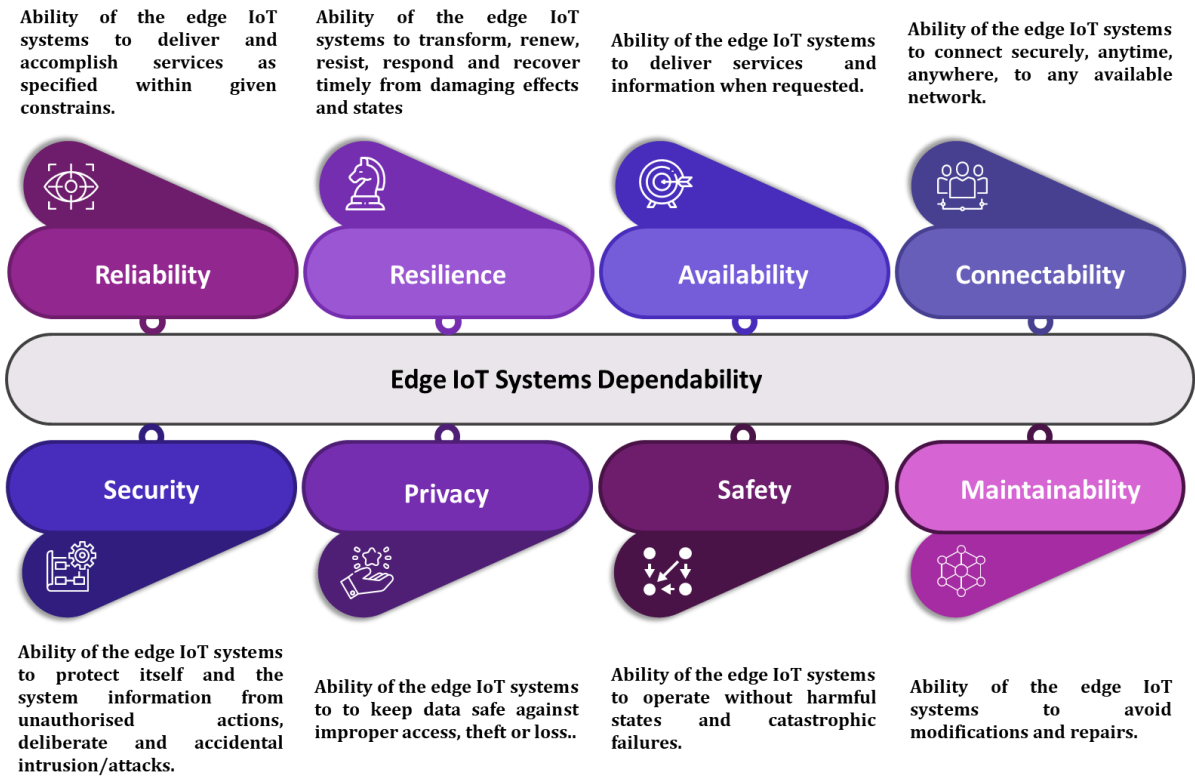
Heterogeneous Edge IoT Systems Integration

- Heterogeneous edge IoT system integration refers to the integration of various HW/SW/AI components and convergence of different technologies into a higher-level IoT system that provides enhanced functionality and improved operating characteristics.
- Research on advances integration concepts in smart sensors/actuators, wireless/cellular ad-hoc networks, embedded intelligence, and operating systems for the IoT edge applications.
- IoT intelligent systems integration through federation of platforms and distributed systems including many heterogeneous IoT devices and smart systems to provide resilience, security and trust for AI-based edge IoT applications.



Trustworthiness and Edge IoT Dependability

- Trustworthiness of the edge IoT systems can be defined as the degree of confidence one has that the edge IoT system performs as expected.
- Trustworthiness of IoT technologies and applications directly connected to the concept of dependability.
- Research on IoT system end-to-end dependability and by-design properties and functionalities.
- Distributed end-to-end security technologies enhance the ability of an IoT ecosystem and its devices to exhibit complex behaviour independently or collectively in the presence of threats.



Summary

- The AIOTI SRIA is composed of sixteen chapters focusing on the current technology layers and their technical challenges along the IoT/edge continuum.
- The chapters address the key technology building blocks as essential ingredients for the next generation edge IoT systems.
- These technology components, as part of integrated advanced heterogenous edge IoT systems, provide some needed and unique features of future applications across industrial sectors.
- The intelligent connectivity, mesh networking, AI, digital twins, and software technologies are all part of the IoT edge continuum for implementing edge IoT systems of systems.

Summary

- The addressed topics are an integrated part of the IoT/edge continuum layered architecture to build the capabilities to advance the digital and green transformation in the future for the benefit of the whole society.
- Addressing the IoT and edge computing key challenges presented in the AIOTI SRIA requires increased efficiency, scalability, resilience, and interoperability for the provided IoT and edge computing solutions.
- The cycle of change must be made more efficient and shortened, rapidly identifying the most promising solutions, and promoting new ideas, concepts, and advanced technologies.

Thank you!

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