HiPEAC Vision 2025

HIGH PERFORMANCE, EDGE AND CLOUD COMPUTING

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HIGH PERFORMANCE, EDGE AND CLOUD COMPUTING

THE NEXT COMPUTING PARADIGM

Funded by the European Union

Building the next computing paradigm

The ‘next computing paradigm’ is the convergence of technologies including the web, cyber-physical systems (CPS), cloud computing, the internet of things (IoT), digital twins and artificial intelligence (AI) into a coherent, federated ecosystem.

European academic and industry leaders need to **act fast** to establish made-in-Europe technologies in this rapidly changing landscape. Technological offerings should **meet the needs of European markets**, while ensuring that European technology is synonymous with **quality and trustworthiness** in the minds of consumers across the globe.

The HiPEAC Vision for the European computing ecosystem is characterized by the following factors, which play to European strengths and establish a ‘European’ flavour of computing:

- Collaborative
- Federated
- Distributed
- Interoperable
- Open source
- Trustworthy (i.e. explainable, reliable, secure, safe and privacy-preserving)
- Sustainable

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POLICY BRIEF: PRIORITIES FOR RESEARCH FUNDING

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RECOMMENDATIONS POLICY: RESEARCH FUNDING PRIORITIES

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1. Technologies for a smart, interoperable, made-in-Europe computing continuum

- European foundation models and specialized action models.
- AI-powered orchestrators and orchestrating technologies.
- Digital envelopes to enable services across the continuum: interoperable runtime systems, service and code migration, optimization for latency, privacy, security, etc.
- AI-assisted software development environments, prioritizing correctness, safety, security, confidentiality and regulatory compliance.

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RECOMMENDATIONS POLICY: RESEARCH FUNDING PRIORITIES

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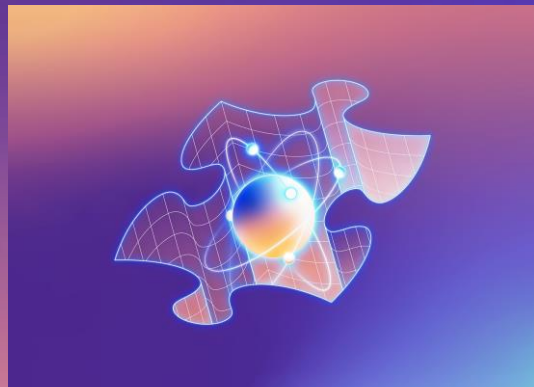
2. Next-generation, designed-in-Europe hardware for the NCP

- Specialized, secured hardware for the edge, able to support services, orchestrators and specialized action models (SAMs) in federated networks.
- Hybrid and non-digital accelerators, moving from exact computations (digital) to approximate computing (Ising, Bayesian, stochastic, etc.).
- Open AI assistants for hardware development, particularly focusing on open domains such as architecture search.



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RECOMMENDATIONS POLICY: RESEARCH FUNDING PRIORITIES

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3. Future-proof, connected safety-critical systems

- Solutions that maximize interactions between safety, security and performance for optimum system adaptability, using techniques such as combined analysis, evaluation and knock-on effects.
- Modular approach to dependability, using adaptive risk management, STPA adaptations, and real-time verification.
- Technologies for performance characterization, damage containment and operational feedback.

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4. A secure and sovereign computing continuum

- Technologies for vulnerability identification at code and component levels.
- Security analyses at orchestrators, services, and communications levels.
- AI models for threat detection and autonomous systems for mitigation.
- Tools to detect and secure against AI model vulnerabilities.

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POLICY BRIEF: PRIORITIES FOR REGULATION AND STANDARDIZATION

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RECOMMENDATIONS POLICY: REGULATION AND STANDARDIZATION PRIORITIES

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1. Standardized protocols for the NCP

Priorities for standardization:

- Expansion of web-level protocols to support 3D spatial and real-time interactions.
- Contract-based APIs for interoperability.
- Open protocols for distributed agentic AI systems.

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RECOMMENDATIONS POLICY: REGULATION AND STANDARDIZATION PRIORITIES

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2. Future-proof cybersecurity regulation for sovereign systems

Priorities for cybersecurity standardization and regulation:

- Standardized representation of software vulnerabilities.
- Mandatory software supply-chain protection.
- AI-specific security certification for large models and autonomous agents.
- Incentivizing EU-based AI models for cybersecurity detection and mitigation.

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RECOMMENDATIONS POLICY: REGULATION AND STANDARDIZATION PRIORITIES

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3. Sustainable digital systems for future generations

Priorities for sustainability regulation:

- Mandatory environmental life-cycle models for digital products and services.
- Mandatory digital product passports with sustainability data.
- Incentivizing circular business models: repair, reuse, hardware-as-a-service, etc.

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RECOMMENDATIONS POLICY: INFRASTRUCTURE

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1. Accelerating competitive EU research and innovation

Priorities for EU research and innovation structures:

- Incentivize the creation of European science and technology clusters.
- A DARPA-style model of key R+I challenges.
- Expanding pre-competitive procurement to accelerate the development of breakthrough European technologies.

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RECOMMENDATIONS POLICY: INFRASTRUCTURE

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2. Strengthening safety-critical system research

Priorities for structures to support complex and critical systems research:

- Develop a research and development dimension for complex, cross-domain integrated research.
- Launch a CERN-style initiative for research into critical and complex systems.

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