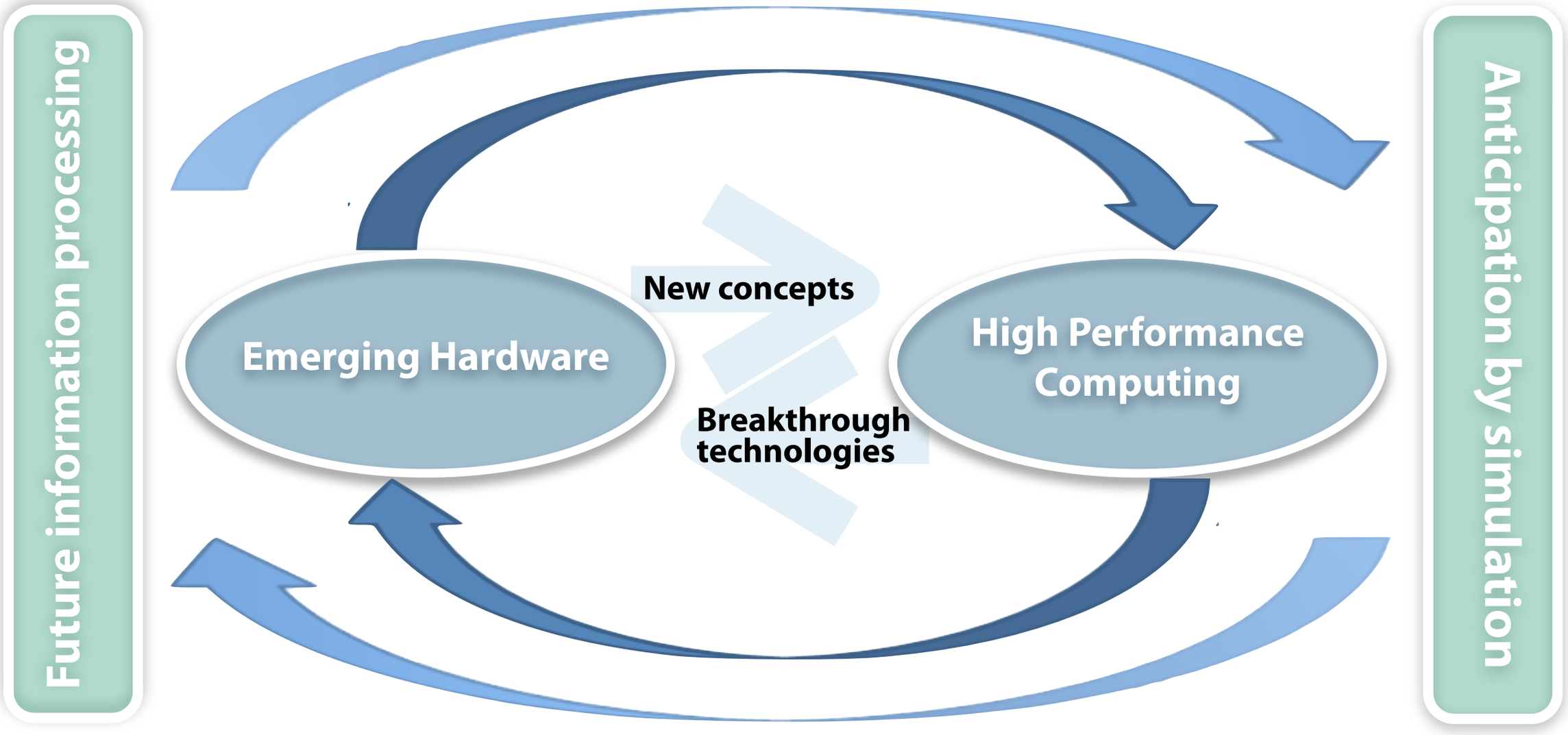
European Leadership in Information processing TEchnologies

ICT beyond limits

- Design future information processing technology that will take ICT beyond the current limits of energy requirements and performances
  - Develop **information processing technologies from atomic scale** and **quantum features up to complex systems** delivering **energy efficient** solutions
  - Anticipation and design by **simulation, insight and validation via a multi-scale approach**, involving extensive use of today's highest performance supercomputers and distributed computing infrastructures



ICT beyond limits ambition

Future Information Processing

Energy efficiency for computers and networks

- New devices requiring less energy and processing more information to power future ICT

Quantum computers

- New components and devices constituting elements in the long-run of HPC facilities

Quantum networks

- Provable secure way of communicating and sharing information (quantum Internet)

Scalable architectures for HPC

- Revolutionary redesign of parallel architectures based on nano-electronics and quantum devices

Design by simulations

Quantum simulations

- Full simulation of physical systems (providing also input for other simulations environments)

Scalable software

- Ab-initio redesign of system, library and application software and tools with scalability beyond the Exascale
- Programming models for quantum computers

Numerical experimentation

- Programming models for quantum computers
- Multiscale-multiphysics simulation from ab-initio to systems

Advanced predictive design architectures

- Full articulated ensemble of simulating tools reaching a predictive capability allowing design of engineering systems

Massive data storage and use

- Advanced adaptive databases and retrieval tools

Beyond the "Super IP" concept

- Training at all levels (accademic+industrial)
- Integration of diverse research infrastructures (labs, cleaning rooms facilities) and processes

ICT beyond limits
impact

- *Enable the coming of the Second Quantum Revolution*
  - Emergence of quantum mechanics as a technology: not just a way to understand what already exists, but to engineer our surroundings to our own needs (from science to technology)
- *Innovation to all levels of ICT*
  - Championing supercomputing at the forefront will be pushing and propagating other levels of ICT usage
- *Foster the rise of a new era in the knowledge-based economy where Europe will be leader*
  - The discoveries of the laws atomic/nano scale lead to the invention of unprecedented machines for sensing actuation and communication and pave the way to numerical experimentation and predictive design of engineering systems
- *Foster a stronger structuring of the European research communities involved*
  - New components, devices, tools and simulation environments will accelerate research in basic and applied sciences
- *Important implications for European economic competitiveness*
  - New and innovative technologies, health care, security, privacy, data protection, energy efficiency, ambient intelligence
- *New service providing business model*
  - Allows a large number of SMEs to access state-of-the-art design tools for in-house design (return on investment on a pay-per-connect basis)

ICT beyond limits
integration

- *Strongly multidisciplinary by nature*
  - Science disciplines: physics, chemistry, mathematics, engineering and computer science
  - A variety of disciplines in computer science
- *Relies on intensive use of European available resources*
  - Integration research infrasturcture, specialized labs and clean room facilities for nanotechnologies, large scale research instruments and HPC centers
- *Will gather industrial participation*
  - End-users: energy, nano-electronics, health, materials, transport, aeronautics
  - Sectors providing innovative solutions by leveraging the tremendous capabilities offered by novel classical and quantum technologies and hardware and simulation/design software
- *Federate and transcend several EU efforts*
  - The EMBL, House of Simulation network, ETSF, CECAM++, HM research, JRC PETTEN, GENESYS
  - The Supercomputing E-Infrastructure “Partnership for Advanced Computing in Europe” (PRACE);PROSPECT (HPC technologies); HIPEAC and EESI (Exascale software)
  - FET Proactive Initiatives: Quantum Information Foundations and Technologies, NANO-ICT, Molecular Scale Devices and Systems, Zero-Power Computing; Nonlinear-stochastic-dynamics European networks
    Plus: initiatives addressing atom chips and atom lasers, spintronics, single nano objects, disruptive photonics and similar topics

ICT beyond limits
plausibility

Future information processing

Anticipation by simulation

- Irruptive situation generated by the multicore era and new prospects of Exascale computing
- Constant progress in quantum technologies
- Convergences of technologies that are allowed by mastering matter at the quantum level and the nanoscale
- Progress in realization of nanoscale devices and experimental investigation of their physical properties

New concepts

Emerging Hardware

Breakthrough technologies

High Performance Computing

- Maturity of the large scale instruments and of their capabilities to validate models of unitary processes
- Progress in simulation at the nanoscale and for multi-scale integration to describe complex systems
- Proactive development of HPC in Europe leading to a large increase of the available computing power (petaflop-class computers) and of the simulation expertise

- Development in atomic and nanoscale science including non-equilibrium thermodynamics and associated basic statistical sciences
- Increasing interest in energy efficient ICT for the future reduction of the ICT originated Carbon footprint (SMART2020 report)

- Development of distributed computation by cloud computing
- Acceleration of the research agenda on adaptive databases
- Experience of European CAD industry, to master numerical centers and simulation environments

ICT beyond limits
support

- *Communities*
  - Computer Science; Quantum Information Processing and Communication; PRACE; Noise and nm-scale thermal engineering
- *Institutions*
  - CHIST-ERA participants (AT, CH, DE, ES, FR, IE, IT, PL, UK,)
- *Main European industrial players*
  - CAD vendors, PLM providers, Large integrating systems industry, Design Houses
  - Companies (examples)

    ARC Seibersdorf, Atos Worldline, Belgian Defense, Bell Labs, Lucent Technologies, BookhamBSI, Bundesamt fÜr Sicherheit in der Informationstechnik Corning, Crescendo Ventures, D-Wave Systems Inc., DANTE, Elsag, ETSI - European Telecommunications Standards Institute, FTTH Council Europe GCHQ, HP Labs, IBM, Zurich Research Laboratory - Identity Management and Privacy Group, id Quantique SA, Infineon Technologies, JDSU Optical Communications groups, JENOPTIK AG, MagiQ Technologies, Inc., Meriton Networks, METAS, NEC, Omnisec, Ovum RHK - Network Infrastructure, ParTec Cluster Competence Centre, Philips Research, Pirelli, QuTools, Senetas, Siemens AG, Smals-Egov, Smart Quantum, STMicroelctronics, Technology Strategy Board, Thales, Toshiba Research Europe Ltd, Zetes PASS, Zurich Research Laboratory