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## Advanced Computing

Embedded ICT, cyber-physical systems and the advent of the Internet of things will allow the development of customised heterogeneous low-power computing systems delivering high-performance functionality in the next decade.

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The move towards low-power consumption for embedded systems, mobile devices, desktops or even data centres is a key and structural evolution of computing. The demand for low-power multi/many-core computing systems is intensifying across all computing market segments and it will underpin progress across the whole computing spectrum.

To exploit synergies and broaden business opportunities for European actors, different market segments must be addressed through an integrated cross-layer (hardware, system, programming, algorithms) and cross-application/cross-market approach.

Under our research programmes (FP7 and Horizon 2020), research and innovation is supporting the concept of scalable advanced computing systems such as micro-server/form-factor data centres. Small "data-centres-in-the-box" can be deployed individually or clustered in an embedded system in the car or a telephone switch, or can be clustered at large scale to become a Cloud server or – if complemented for example by Graphics Processing Units (GPUs) – a High Performance Computing (HPC) system.

One of the key challenges ahead is mastering the optimisation space including parameters such as:

- performance,
- data movement,
- energy consumption and carbon footprint,
- dependability and time-criticality,
- security and privacy,
- price.

With multicore becoming conventional, also parallelism is becoming mainstream. Your latest generation laptop at home will be based at least on a quad-core system and likely include a GPU for acceleration of graphics and computation. One of the major research tasks to address is mastering parallelism, concurrency, heterogeneity, hierarchies of memory and storage, and different levels of connectivity from hardware to system software, to services and to applications - while at the same time staying "productive" and requiring only a limited level of skills.

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