HTA – Heterogeneous Technology Alliance

European cooperation in microtechnologies, nanoelectronics and smart systems

White Paper 2015

Cyber Physical Systems

Building Blocks for the Internet of Things

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Urban Development – Electric Mobility – Industry 4.0 – Demographic Change – Climate Crisis – Internet of Things – Shareconomy… **the world is changing fast and entire industries are reinventing themselves in response to complex transitions in social, economic, and environmental arenas** (http://www.morgenstadt.de).

Since long, ***Micro- and Nanoelectronics*** has become the most prevalent key enabling technology needed everywhere to meet these challenges. The complexity of electronic systems is steadily increasing. Technology drivers have changed from *components* to *Smart Integrated Systems* or *Cyber-Physical Systems*. Micro-/Nanoelectronics and the closely related MEMS- and nano-technologies are therefore the major building blocks for innovative, competitive and highly performing products and services needed to serve the global markets.

Today, it is not possible to imagine discussions on future technological challenges and industrial trends without talking about ***Cyber-Physical Systems*** (CPS) which is defined as "systems of collaborating computational elements controlling physical entities" (Wikipedia). By using Cyber-Physical Systems, a system of systems will be built up which is not only able to map the real world, but to gather it in its entirety, to control and to steer it. Cyber-Physical Systems can be used in most different applications like smart energy distribution, logistics, safety/security/surveillance, traffic control, and fitness/health monitoring, but also in industrial automation (Smart Manufacturing/Industry 4.0).

The concept of Cyber-Physical Systems has its origin in different ideas like »Smart Objects«, »Ambient Intelligence«, »Ubiquitous Computing« and »Internet of Things«. All these approaches have in common that they are based on the so-called *More-Moore* and *More-than-Moore* technologies, combining sensors, actuators, signal processing, power supply and means of communication into a single package or chip.

Typical CPS applications are built from sensor-based communication-enabled autonomous systems. For example, wireless sensor networks monitor environmental data, perform some preprocessing and data fusion, and transmit the compressed data to a central node (fog computing). A big, upcoming application area for Cyber-Physical Systems is the industrial domain, where Cyber-physical Systems and their link to Cloud technologies are the basis for Smart Manufacturing technologies, because expectations are high for tomorrow's manufacturing. Factories must be smart, changeable, efficient and sustainable. Therefore, *Smart Manufacturing* and *Industry 4.0* stand for an intelligent networking of product development, production, logistics and customers, enabled by micro-/nanoelectronics and Smart Systems.

Other upcoming application examples are *Smart Cities*, where Cyber-Physical Systems will help to manage the increasing complexity of future Mega Cities and autonomous driving which is closely related to Smart Cities and *Electro Mobility*.

To be prepared for above mentioned challenges, the four partners of the *Heterogeneous Technology Alliance (HTA)* – CEA-LETI (FRA), CSEM (SUI), Fraunhofer Mikroelektronik (GER) and VTT (FIN) – have joined forces and pooled their focused expertise on microtechnologies, nanoelectronics and smart systems into the *Heterogeneous Technology Alliance (HTA)*. Building the bridge over the so-called "valley of death" between academia and industry, the objective of this wide-ranging Alliance is to carry out joint research projects and develop innovative solutions. The HTA partners are active at all levels of Cyber-Physical Systems development dealing with both, higher technological readiness levels (TRLs), applications, and services. For serving its customers best, the HTA Alliance is open for external cooperation whenever additional competences are needed.

The mission of the comprehensive HTA alliance is **to ensure competitiveness of European industry through cutting-edge research and technology transfer services**.
This will be done by

- Developing CPS-based innovative solutions and products for industry
- Developing key enabling technologies in microtechnologies, nanoelectronics and smart systems
- Developing infrastructure in coordination and collaboration for research, piloting and small scale production

The main focus of HTA lies on the further development of innovative Cyber-Physical Systems which are aiming at a most efficient use of resources like energy and rare materials.

This requires significant efforts in technological development for new sensors and actuators adopting nanoscale effects to microsystem applications, solving the challenges of energy harvesting and energy storage and management, developing new and more efficient system architectures by learning from nature, as well as further miniaturizing technical systems.

Providing adequate education for young people and maintaining and extending the technological knowledge base is a prerequisite to keep production of high-end systems in Europe. Production is needed to maintain a sufficient employment rate and create a value added high enough to increase quality of life and to reduce social exclusion. **Therefore HTA will act as a key pillar for the bridge between academia and industry which will help to** overcome **the "valley of death" between invention and innovation.**

The HTA-*partners appreciate the support from local and federal authorities as well as from the European Commission. Enhanced support of European Research Alliances like HTA is necessary to form a joint European Research Community which is able to take over the lead on Smart Systems Development in the global competition. The foundation of HTA was a first step towards this goal. HTA has become a voice being heard in Europe and will act as a Think Tank for the European Commission.*