OBJECTIVES & BENEFITS

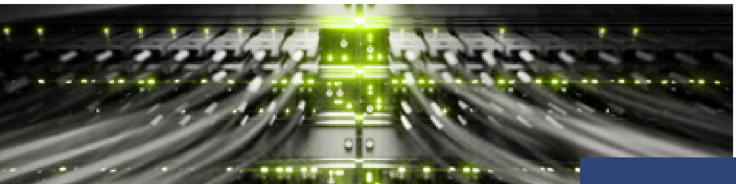
OBJECTIVES DEEP PROJECTS

- Develop a **flexible architecture** that accommodates **heterogeneity** and delivers performance and energy gains to important applications.
- Prove this architecture with **integrated prototype** systems and **real-world applications.**
- Develop a **system software environment** matching applications' needs and addressing I/O, resiliency, resource management and job scheduling.
- Embrace **software/hardware co-design** to ensure maximum value of the architecture, prototypes and system software results.
- **Support** the development and market entry of **European technologies,** e.g. for network fabrics, system integration, cooling, and system software.

BENEFITS FOR USERS AND DATA CENTRE OPERATORS:

- **Highest flexibility:** users can freely define composition of resources for their applications.
- **Ease of use:** porting an application to DEEP systems is straightforward due to the standards-based software environment.
- Significant **reductions** in time and energy to solution.
- **Improvements** in system throughput for heterogeneous workload mixes.
- **Quicker recovery** from failures due to the integrated resiliency mechanisms.
- **Fewer failures** due to resiliency mechanisms in system software.

IN SHORT: **The MSA is an ideal fit** for advanced supercomputing centres.



IN A NUTSHELL

BUDGET:

- € 44 Mio. (EU funding: € 30 Mio.)

PROJECT TERM:

- December 2012 – June 2020

CONSORTIUM:

- Coordinator: Jülich Supercomputing Centre
- 27 Partners
- 12 European countries

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FROM CLUSTER-BOOSTER TO MODULAR SUPERCOMPUTER ARCHITECTURE

The DEEP projects develop a new breed of flexible, heterogeneous HPC systems supporting a broad portfolio of HPC and HPDA applications with highest efficiency and scalability. The development of the underlying architectural concept started in DEEP and DEEP-ER with the Cluster-Booster approach. This architecture integrates two different HPC systems:

- **Standard Cluster:** general purpose multi-core processors (Intel® Xeon®) with high single-thread performance.
- **Extreme Scale Booster:** many-core processors (Intel® Xeon® Phi™) with leading aggregated performance on vectorizable codes and high scalability and energy efficiency.

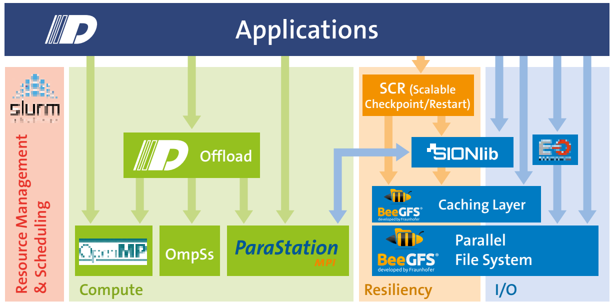
DEEP-EST extends this concept to the **Modular Supercomputing Architecture (MSA)**, integrating various component systems (called modules). The DEEP-EST prototype will consist of the above two modules plus a third one optimized for data analytics and machine learning:

- **Data Analytics Module (DAM):** multi-core processors with high single-thread performance, very large memory size, and node-local accelerators.

All of the modules with their specific networks are connected by the **Network Federation (NF)** component, which provides end-to-end high-speed communication between all nodes across the modules. The concept can in the future accommodate other modules for specific use cases like visualization or novel computation paradigms.

SOFTWARE ENVIRONMENT

The DEEP systems provide an **integrated programming environment.** For ease of use standards such as MPI, OpenMP and Tensorflow or similar frameworks for machine learning and data analytics are used.



In the three DEEP projects different aspects of SW development are in the focus:

- **DEEP Offload** to efficiently distribute applications over several compute modules.
- Highly scalable **parallel I/O system** to efficiently use a multi-level memory/storage hierarchy.
- **Resiliency mechanisms** that support application- and task-based checkpoint/restart.
- **Resource management** and **job scheduling** based on SLURM to determine optimal resource allocation for different combinations of workload on the system.
- **Performance analysis** and **modelling tools** are adapated to the DEEP systems' architecture.

ENERGY EFFICIENCY

Being one of the most difficult challenges on the way to Exascale, this is an important design element addressed on all layers of the HPC stack with:

- Latest **hardware** technology
- Sophisticated **monitoring** systems & energy models to detect inefficiencies
- **Optimisation** of HPC and HPDA **codes**

CO-DESIGN APPLICATIONS

In the three DEEP projects, a total of 15 real-world applications developed in Europe from important scientific and engineering fields are driving the co-design process and shape the HW and SW architecture and prototype implementations. The applications were used in DEEP and DEEP-ER to evaluate the project success and help define the objectives and approach for the next step in the project lineage, and they will serve the same role for DEEP-EST.

As an additional result, the applications were thoroughly analysed and optimized to work efficiently on highly parallel modern systems. These modernized applications will enable more and faster scientific discovery and better engineered products at reduced capital and energy costs, benefitting European research and industry alike.