CASE STUDY

High Performance Computing (HPC)
Intel® Omni-Path Architecture
Intel® Xeon® Scalable Processor

Cineca Prepares for Exascale with the Marconi Supercomputer

Optimized for scientific breakthroughs, Intel® Xeon® Scalable Processors and Intel® Omni-Path Architecture enable Cineca to support demanding computational science

Cineca's Marconi Supercomputer highlights:

- Critical part of Cineca roadmap to reach Exascale computing by 2022
- Total of 18.31 petaFLOPS of Linpack* performance[1]
- 3-stage deployment of Intel® processor-based servers starting in 2016
- Includes nearly 6000 nodes of Lenovo* SD530/S720AP servers based on Intel® Xeon® Platinum processors 8160 and Intel® Xeon Phi™ processors 7250 (total 312,936 cores total)
- Interconnected by Intel® Omni-Path Architecture (Intel® OPA) fabric

Executive Summary

Cineca is a nonprofit Consortium made up of 67 Italian universities, nine Italian Research Institutions, plus the Italian Ministry of Education. The organization provides High Performance Computing (HPC) resources (among other services) to its members, who collaborate in a wide range of research projects across Europe. Discoveries and insight are used to further scientific research and for applications in industry, making Cineca a technological bridge between the world of academics and science and the world of industry.

Chief amongst its HPC resources is the Marconi supercomputer, a large HPC system built by Lenovo* on Intel® processors and Intel® Omni-Path Architecture fabric. Marconi is a critical step along Cineca's roadmap to be an Exascale computing center by 2022.

Challenge

Cineca is a major supercomputing center that supports research for scientific discovery and applications in industry within Italy and across Europe. Cineca supports computing for projects in the European Center of Excellence (CoE) in HPC Applications, and it is part of the EuroHPC project, a joint collaboration across the EU to develop Exascale computing facilities. Cineca is also a partner of the Materials Design at Exascale (MaX) project, also a European CoE.

Cineca's long-term roadmap includes delivering Exascale computing by 2022. With its aggressive supercomputing plans, critical stakes in many advanced research projects, and a philosophy to always stay on the very competitive edge of HPC, Cineca needed to build next-generation, powerful supercomputing resources for a very wide range of workloads.

Solution

Marconi was envisioned to deliver up to 20 petaFLOPS of performance to support some of the most advanced research in material science, astrophysics, engineering, bioinformatics, weather and climate, and other fields in Italy and across Europe. To drive research in these fields forward, the system required very large-scale computing capabilities. That meant an infrastructure with hundreds of thousands of cores designed for compute-intensive HPC workloads, such as ab initio materials science and molecular modeling, weather and climate modeling, plasma physics simulation, large-scale bioinformatics, and many other demanding problems.

The designers of Marconi built on Cineca's early experiences with Intel® Xeon® processors and Intel® TrueScale network adapters (the pre-cursor to Intel® Omni-Path Architecture—Intel® OPA). For their next-generation supercomputer, they chose Intel Xeon processors, Intel® Xeon Phi™ processors, Intel® Xeon® Scalable

Cineca's Marconi supercomputer built by Lenovo* utilizes Intel® Xeon® Scalable and Intel® Xeon Phi™processors and Intel® Omni-Path Architecture fabric.

processors, and the Intel OPA fabric to interconnect a very large system that could deliver the performance researchers demand to enable new insights through numerical simulation and computational science. The system was built and deployed by Lenovo using their NeXtScale* platform.

Beginning in 2015, the first set of 720 nodes was deployed (Marconi-A1) with 25,920 cores using Intel Xeon processor E5-2696 v4. In 2016, Lenovo deployed the largest partition (Marconi-A2) of 244,880 cores across 3,600 nodes of Intel Xeon Phi processor 7250 with 68 cores per node. In 2017, another 110,592 cores were added in 2,304 nodes (Marconi-A3). This gave Cineca a large number of cores across Intel's multi-core and many integrated core (MIC) architectures. Marconi has consistently placed within the top 20 fastest supercomputers in the world since November of 2016[2].

Result

Cineca is a partner of the MaX CoE—Materials Science at the Exascale—European Center of Excellence for HPC applications. It was initially included in 2016 when Marconi was first deployed. It was awarded another three years of inclusion in 2018. Marconi continues to be a critical part of research and design across Europe.

Fifty percent of Marconi's workloads come from projects across Europe, representing over 100 million Euros in funding. The balance of Marconi is dedicated to researchers within the country. One of the main sciences is materials research, involving compute-intensive electronic structure workloads.

Supporting such depth and breadth of computational sciences requires Cineca to be integral in optimizing popular open source codes, such as Quantum Espresso*. Carlo Cavazzoni of Cineca, has contributed to the Quantum Espresso (QE) project for 20 years, and is integral to optimizing multiple workloads, including QE, on Intel Xeon Phi processor. He has also supported work on proprietary plasma physics codes. Those optimizations have enabled significant speedups on projects running on Marconi's Intel Xeon® Scalable Processor and Intel Xeon Phi™ processor nodes.

Andrea Ferretti is a researcher in the field of condensed matter and solid state physics at Italy's National Research Council (CNR). Using Marconi, his computational work in ab initio simulations for electronic structure and excitations has been crucial in work that has revealed new electroluminescence properties for graphene nanoribbons (GNR) and abilities to control the coupling of spin interfaces with high thermal stability.

Solution Summary

Cineca is Italy's premier center for supercomputing and a key center for computational support for projects across Europe. Marconi is Cineca's latest HPC resource built on Intel Xeon Scalable Processors, Intel Xeon Phi processors and Intel Xeon processor E5 v4 family with Intel OPA as the interconnecting fabric. The system was built by Lenovo and deployed in three phases from 2016 through 2018. Marconi has consistently placed in the top 20 supercomputers on the Top500 list.

Where to Get More Information

Learn more about Intel Omni-Path Architecture at https://www.intel.com/hpcfabrics.

Find out more about Intel Xeon Scalable Processor family at https://www.intel.com/content/www/us/en/products/processors/xeon/scalable.html.

Find out more about Marconi at http://www.hpc.cineca.it/content/hardware.

Solution Ingredients

- Lenovo NeXtScale* platform
- Intel® Xeon® Processor E5-2697 v4, Intel® Xeon Phi™ Processor 7250, Intel Xeon Platinum 8160 Processor: total of 6,624 nodes with 381,392 cores
- Intel® Omni-Path Architecture Edge Switches, Director Switches, and Host Interfaces

1. Theoretical performance calculated by Cineca for November 12, 2018 Top500 ranking: https://www.top500.org/system/178937
2. https://www.top500.org

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