More than powerful: German research computer QPACE is the most energy efficient in the world

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At the 2009 Supercomputing Conference in Portland, Oregon, the high-performance computer QPACE (QCD Parallel Computing on the Cell) was recognized today as the most energy-efficient supercomputer in the world.

QPACE is at the head of the Green500 list, which provides a global ranking of energy-efficient supercomputers. QPACE was developed by an academic consortium of universities and research centers as well as the German IBM research and development center in Böblingen within the framework of a state-sponsored research association. Within the consortium, the development effort was led by the University of Regensburg, while the research centers DESY and Jülich also assumed central responsibilities. Additional members included the University of Wuppertal, the University of Ferrara (Italy), the University of Milan-Bicocca (Italy) as well as the companies Eurotech, Knürr, Zollner and Xilinx. The QPACE core team consists of approximately 20 researchers and developers.

QPACE was deployed mid 2009 with four racks each at the Research Center Jülich and at the University of Wuppertal. It is being used for the simulation of fundamental forces in elementary particle physics, especially in the research area of quantum chromodynamics (QCD). QCD describes, for example, how a proton is made up out of quarks and gluons. QPACE is being used by members of the Collaborative Research

Center/ Transregio 55 "Hadron Physics from Lattice QCD," which is located at the Universities of Regensburg and Wuppertal and supported by the German Research Foundation (DFG). Spokesperson of the research association is Prof. Dr. Andreas Schäfer; Principal Investigator of the QPACE project is Prof. Dr. Tilo Wettig. Both teach physics and perform research at the University of Regensburg.

For a long time, in the world of supercomputers performance was solely associated with speed. This notion led to the development of computers that use enormous amounts of energy. Energy efficiency usually was ignored. Not until the advent of increased discussions about the scarcity of natural resources and energy over the past years did this aspect gain in importance for the development of supercomputers. Along with the Top500 list of the fastest computers, the Green500 list of supercomputers with the least energy use emerged as criterion for the rating and ranking of computer performance. Both lists are updated and presented twice a year at the international Supercomputing conference. The QPACE supercomputer comes in at place 110 on the TOP500 list and has a computing power of 55 teraflop/s.

The heart of QPACE is the IBM PowerXCell 8i processor, an enhancement of the Cell/B.E. processor, which originally was developed by Sony, Toshiba and IBM for the Sony PlayStation 3. With its nine processor cores, the chip can carry out a very large number of calculations simultaneously and at a high speed. The novel concept of QPACE consists of connecting processors by a network of programmable units, called Field Programmable Gate Arrays (FPGA), to an efficient scalable computer. Each of the QPACE installations in Jülich and Wuppertal can reach a maximum performance of 100 TeraFlops (double precision). That equates to 100 trillion (100,000,000,000,000) computing operations per second. As a result of the scalability of the network, it is in principle possible to increase the performance to the PetaFlops scale (one quadrillion operations per

second). The technology concepts developed for the QPACE project are setting the trend for future high-performance computers. One example of this is the new cooling concept developed in the IBM research and development center in Böblingen, which can contribute significantly to the energy efficiency of future supercomputer installation.

The DFG as well as the states of Bavaria and North Rhine Westphalia are bearing the costs of QPACE in the amount of approximately three million euros. The consortium and IBM are dividing the development costs between themselves. Additional subsidies within the framework of the eQPACE project of the European research initiative PRACE (Partnership for Advanced Computing in Europe) serve to develop a more general communications structure for the FPGA network and thereby to open QPACE to a wider range of applications. In this context, Prof. Dr. Dr. Thomas Lippert, director of the Jülich Supercomputing Center and professor for computational theoretical physics at the University of Wuppertal, explained, "The development of energy-efficient supercomputers for all application areas is a vital future challenge and a focal point of Jülich's research activities."

More information: Additional information about QPACE: arxiv.org/pdf/0911.2174

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