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A supercomputer in the palm of your hand

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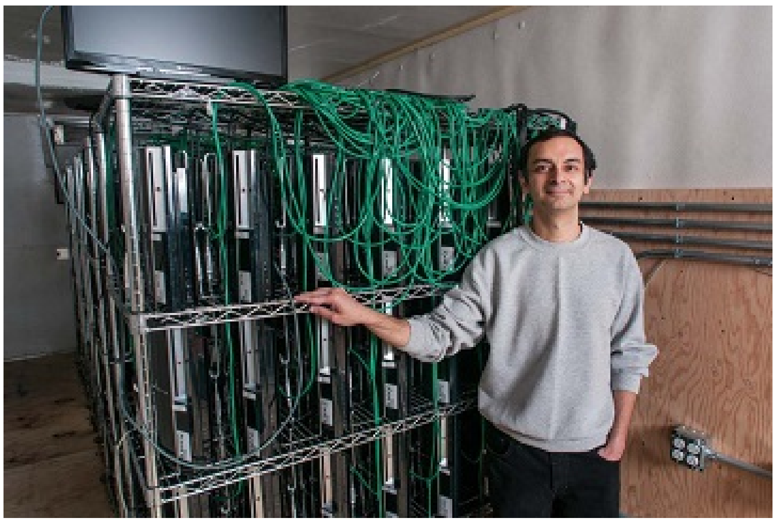

The same professor who received national attention for discovering that PlayStation 3 (PS3) technology could be configured into low-cost supercomputers has now demonstrated that the processor found in hundreds of millions of cell phones has enormous scientific computing potential. The impact of this discovery could have far-reaching impacts for scientists around the world, who have a wealth of curiosity and ingenuity but sometimes lack access to expensive standard supercomputing technology.

"It is about making supercomputing more accessible to scientists, mainly through offering very highly cost-effective alternatives," said UMass

Dartmouth Associate Professor Dr. Gaurav Khanna, who serves as Associate Director of the fast emerging Center for Scientific Computing and Visualization Research (CSCVR). "Bottom-line, supercomputers need to be more power efficient and perform well using much less electricity. And that is an area where smartphones have done very well. Improving battery technology is hard, but improving the efficiency of chips found in most smart phones is much easier."

Global technology companies such as Qualcomm, Apple, and Nvidia have been making mobile phone chips more and more power-efficient according to Dr. Khanna and thus offering people a better experience on their phones even though they have the same battery technology.

"Consumer demand for better performance and longer lasting battery life have pushed technological innovation in the consumer mobile phone industry to the extreme," Dr. Khanna said. "Today's smartphones are extremely powerful, equivalent to supercomputers of the early '90s, and are the most power-efficient computer technology ever made."

The idea of using video-gaming components like PS3s and graphics-cards yields a 10-fold cost-related benefit compared with traditional supercomputer parts. This is because the consumer gaming market is huge and intensely competitive as compared to the supercomputer market and that brings the cost down, even for the very high-end and powerful gaming technology. Dr. Khanna and his fellow researchers have found a way to re-purpose or 'misuse' the same parts for scientific supercomputing and that offered lots of savings. The idea now being researched by Dr. Khanna is whether that same strategy can be applied to chips found in our phones.

At the urging of Qualcomm founder Irwin Jacobs, who grew up in nearby New Bedford and whose Snapdragon processors revolutionized the cell phone market worldwide, Dr. Khanna and his team started examining the power and efficiency of the phone chip processors, which could help with the costly electrical consumption issue.

Dr. Khanna and CSCVR researchers have performed very early and initial tests on that idea. They were able to discover that if a supercomputer was built using mobile phone chips it would use 30 times less electricity for the same performance from traditional supercomputer servers. To build an actual supercomputer, many more such chips will be needed and linked together similar to Dr. Khanna's PS3 cluster. Dr. Khanna's team cautions that they have only tested a single chip. However, this is a very positive sign in the early testing stages with a potential for huge savings on operating costs.

Dr. Khanna and his fellow CSCVR researchers are now exploring the potential of Qualcomm Snapdragon technology to perform very high-efficiency scientific supercomputing. The team is using Inforce Computing's SBC to evaluate Snapdragon's ability to run full-scale astrophysics and computational mathematics research codes.

The main point to be made Dr. Khanna argues is that the cost of electricity surpasses the cost of the purchasing the computer. Dr. Khanna installed his PS3 cluster in a refrigerated shipping container "reefer" of large cooling capability located conveniently on the University's campus. This system's performance is comparable to nearly 3000 processor-cores of a typical laptop or desktop. The novel approach that was developed involved the purchase of a refrigerated shipping container, or "reefer", of adequate size and cooling capacity and locating it conveniently on campus with power and network drawn from a nearby building. Such an approach is extremely low-cost given the abundant availability and high cooling capacity of these containers.

"When people think of supercomputers, and especially the expense associated to them, they always think of the cost to purchase and install one," Dr. Khanna said. "However, once you run a supercomputer for more than a year or two there is another cost that is far more important in raw dollars terms. And that is the cost of the electricity to run it and keep it cool. In fact, once you have run a supercomputer for a few years, the cost of the initial purchase ends up being a small fraction of the total cost of running the machine. Very few people know about the significance of that operating cost and its overall importance."

The need to grow supercomputing resources is critical for national competitiveness and for the future of STEM research. New designs for buildings, wind turbines, and other large structures and machines are hard and expensive but modeling them on a computer is much easier. It is cheaper to simulate than to fabricate reasons Dr. Khanna. This is at the core of the recent growth in supercomputing. Almost all engineering and science research is now partly or wholly done on supercomputers.

The concept of using consumer gaming hardware, such as PlayStation 3 consoles, to build low-cost supercomputers has been appreciated and implemented for several years now at various locations around the world. The approach was pioneered by Dr. Khanna back in 2007 when he built a small eight PS3 cluster and was able to perform research grade simulations of black hole systems with it. The Air Force Research Lab (AFRL) in Rome, New York, implemented the same approach at a very large scale in 2010, using 1,716 PS3s and was able to demonstrate ten-fold cost effectiveness of such a system over traditional supercomputers. The AFRL has now granted a significant chunk of their cluster to CSCVR.

"It is well known that if we attempt to build the next generation supercomputer using today's technology, we will need multiple nuclear power stations to simply turn it on," Dr. Khanaa said. "Power-efficiency is the key in the future of supercomputing and that is why I am convinced that the next generation machines will be built using mobile phone parts."

CSCVR's current computational resources are being utilized to solve complex problems in areas ranging from designing better ocean wave-energy converters to uncovering the mysteries of black hole physics. In the Mechanical Engineering Department, Dr. Mehdi Raessi's research group uses these resources to perform detailed simulations of fluids around solid objects which help design various devices like wave-energy converters and wind turbine blades. Researchers in the Mathematics Department share these same resources to develop new algorithms to solve complex mathematical equations. School for Marine Science and Technology Professor Geoffrey Cowles and Mechanical Engineering Professor Amit Tandon make use of the systems to develop ocean simulation models and make important predictions of ocean conditions around the world. Researchers in the Physics Department study fascinating phenomena related to stellar evolution and black hole systems.

Provided by University of Massachusetts Dartmouth