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LSU CCT's researchers develop Melete, among first interactive supercomputers

In today's society, interactivity is a constant buzzword—it is hard to imagine a person who has not seen a smart phone or a tablet. But how about an interactive supercomputer? Not so common. Since 2011, researchers at Louisiana State University's Center for Computation & Technology (CCT) have been working to envision what interactivity with these big machines could mean. CCT's Brygg Ullmer, who is also an associate professor of computer science at LSU, is leading a team of some 40 co-investigators across 11 departments in 5 colleges on a ca. $1 million grant from the National Science Foundation to develop Melete.

Melete, the Greek mythology muse of practice, is a system that integrates an interaction-oriented compute cluster with tangible interfaces to support collaborative research and the classroom. As with all CCT faculty, staff, students, and equipment, in August 2013 the Melete cluster moved to the brand-new Digital Media Center on South Stadium Drive on LSU's campus.

"In the classroom, laboratories, and meeting rooms, faculty today choose between real-time interaction with the limited capability of a laptop or podium PC or no interaction at all," said Melete's principal investigator Ullmer. "Through Hollywood, everyone is aware of the simulation potentials of large-scale computation. We aspire to bring some of these powers of interactive hurricane simulations, of flowing hair and animation work to what students and faculty are controlling and experiencing live in the classroom as well as at a research meeting."

CCT's IT consultant and adjunct faculty of computer science Chris Branton has been leading the development of software infrastructure for the project.

"Typically, a high-performance computer would feature one head node coupled with several slave nodes," Branton said. "In contrast, Melete features several interactive face nodes in addition to the head node. These are a combination of dynamic screens, passive printed visuals, addressable LEDs, and other interactive elements. They are planned to be placed in labs, meeting spaces, and classrooms both at CCT and elsewhere on LSU campus to give interactive control of the machine to authorized users," he said.

Five research domains are expected to benefit from Melete–computational biology, materials, mathematics, engineering, and arts. LSU professor of chemistry Les Butler, who co-leads the project, explained how the new system has helped his research of flame-retardants and X-ray interferometry for materials science.

"This area of research is just a few years old, so our software is under rapid development, and it is a tremendous advantage to use Melete with our new Mathematica codes," Butler said. "The data rate of X-ray imaging is huge—a couple of days yields roughly one TB of data. How can we present these results to our collaborators? Melete helps us extract the good stuff," he said.

"As our interface for this, we are using four iPad minis to fly-through the optical, absorption, dark-field, and differential phase contrast (one image type per iPad)," Butler said. "It's strange, but it seems to work. We can discover features in the data sets walking to and from the coffee shop that would otherwise tether us to the workstation."

"By the way, X-ray interferometry may soon appear in clinical applications as low-radiation dose imaging. Researchers at the National Institute of Health are exploring this new X-ray method for applications such as mammography," Butler added.

Jinghua Ge, visualization consultant at CCT who is collaborating with Butler on the flame-retardant research, explained how Melete is enhancing her work. "The old-fashioned visualization software is not keeping up with the data growth, and personal computers are just not powerful enough to provide large-scale interactive data exploration. We use the VisIt parallel software to visualize large-scale scientific data on Melete," Ge said.

"By setting up a Melete host profile for remote parallel computation, VisIt's GUI interface runs locally at the user's desktop, while the computation is distributed seamlessly to Melete," she said. "VisIt running on Melete enables large-scale data exploration as an investigative process through high performance and event-driven computation," she added.

Landon Rogge, a senior in computer science at LSU, has played an active part of the Melete team as well, facilitating simpler access to the Melete system for scientists who are unfamiliar with command-line interfaces. "After graduation in May 2014, I plan to apply to the FBI to pursue a career in fighting cyber-crime, which frequently involves the use of HPC systems and other tools I learned on the Melete project," he said.

Who knows, maybe over the next decade, a smart phone will function as a multi-hundred core personal device. Ullmer and the Melete team are certainly moving in that direction.

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