HYPERION RESEARCH

HPC User Forum Update

Interviews with HPC Community Leaders: Travis Humble, Oak Ridge National Laboratory

Steve Conway and Thomas Gerard
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IN THIS UPDATE

After the global pandemic forced Hyperion Research to cancel the April 2020 HPC User Forum planned for Princeton, New Jersey, we decided to reach out to the HPC community in another way – by publishing a series of interviews with leading members of the worldwide HPC community. Our hope is that these seasoned leaders' perspectives on HPC's past, present and future will be interesting and beneficial to others. To conduct the interviews, Hyperion Research engaged insideHPC Media. We welcome comments and questions addressed to Steve Conway, sconway@hyperionres.com or Earl Joseph, ejoseph@hyperionres.com.

This interview is with Travis Humble, Deputy Director at the Department of Energy's Quantum Science Center, a Distinguished Scientist at Oak Ridge National Laboratory, and director of the lab's Quantum Computing Institute. Travis is leading the development of new quantum technologies and infrastructure to impact the DOE mission of scientific discovery through quantum computing. He is editor-in-chief for ACM Transactions on Quantum Computing, Associate Editor for Quantum Information Processing, and co-chair of the IEEE Quantum Initiative. Travis also holds a joint faculty appointment with the University of Tennessee Bredesen Center for Interdisciplinary Research and Graduate Education, where he works with students in developing energy-efficient computing solutions. He received his doctorate in theoretical chemistry from the University of Oregon before joining ORNL in 2005.

The HPC User Forum was established in 1999 to promote the health of the global HPC industry and address issues of common concern to users. More than 75 HPC User Forum meetings have been held in the Americas, Europe and the Asia-Pacific region since the organization's founding in 2000.

TRAVIS HUMBLE INTERVIEWED BY DOUG BLACK, insideHPC

Black: Hi, everyone. I'm Doug Black. I'm editor-in-chief at InsideHPC and today we are talking with Dr. Travis Humble. He is a distinguished scientist at Oak Ridge National Lab, where he is director of the lab's Quantum Computing Institute. Dr. Humble, welcome. Thanks for joining us today.

Humble: Thanks for having me on, Doug.

Black: Travis, tell us, if you would, the area of quantum computing that you're working in and the research that you're doing that you're most excited about that has what you would regard as the greatest potential.

Humble: Quantum computing is a really exciting area, so it's really hard to narrow it down to just one example. This is the intersection of quantum information—quantum mechanics—with computer science. We've already recognized that we can accelerate solving scientific applications using quantum computers. At Oak Ridge, for example, we have already demonstrated examples in chemistry, material science and high-energy physics, where we can use quantum computers to solve problems in those areas. These demonstrations are just early examples of how we expect quantum computers can take us to the most challenging problems for scientific discovery. My own research is actually focused on how we could integrate quantum computers with high-performance computing systems. Of course, we are adopting an accelerator model at Oak Ridge, where we are thinking about using quantum processors to offload the most challenging computational tasks. Now, this seems like an obvious approach; the best of both worlds. But the truth is that there are a lot of challenges in bringing those two systems together.

Black: It sounds like sort of a hybrid approach, almost a CPU/GPU, only we're talking about systems writ large. Tell us about DOE's and Oak Ridge's overall quantum strategy and how the Quantum Computing Institute works with vendors and academic institutions on quantum technology development.

Humble: The Oak Ridge National Laboratory has played an important role within the DOE's national laboratory system, a leading role in both research and infrastructure. In 2018, the President announced the National Quantum Initiative, which is intended to accelerate the development of quantum science and technology in the United States. Oak Ridge has taken the lead in the development of research, especially software applications and hardware, for how quantum computing can address scientific discovery. At the same time, we've helped DOE establish a quantum computing user program; something we call QCUP. This is administered through the Oak Ridge Leadership Computing Facility and it looks for the best of the best in terms of approaches to how quantum computers could be used for scientific discovery. We provide access to the users through the user program in order for them to test and evaluate how quantum computers might be used to solve problems in basic energy science, nuclear physics, and other areas.

Black: Okay, great. So how far would you we are from practical quantum computing and from what is referred to as "quantum advantage," where quantum systems can run workloads faster than conventional or classical supercomputers?

Humble: This is such a great question. Quantum advantage, of course, is the idea that a quantum computer would be able to outperform any other conventional computing system on the planet. Very early in this fiscal year, back in October, there was an announcement from Google where they actually

demonstrated an example of quantum advantage using their quantum computing hardware processor. Oak Ridge was part of that announcement, because we used our Summit supercomputer system as the baseline to compare that calculation. But here's the rub: the Google demonstration was primarily a diagnostic check that their processor was behaving as expected, and the Summit supercomputer actually couldn't keep up with that type of diagnostic check. But when we look at the practical applications of quantum computing, still focusing on problems in chemistry, material science, and other scientific disciplines, we appear to still be a few years away from demonstrating a quantum advantage for those applications. This is one of the hottest topics in the field at the moment, though. Once somebody can identify that, we expect to see a great breakthrough in how quantum computers can be used in these practical areas.

Black: Okay. So, how did you become involved in quantum in the first place? Tell us a little bit about your background in technology.

Humble: I started early on studying quantum mechanics through chemistry. My focus, early on in research, was on theoretical chemistry and understanding how molecules behave quantum mechanically. What has turned out to be one of the greatest ironies of my career is that quantum computers are actually significant opportunities to solve chemistry problems using quantum mechanics. So, I got involved in quantum computing relatively early. Certainly, the last 15 years or so have been a rollercoaster ride, mainly going uphill in terms of developing quantum computers and looking at the question of how they can intersect with high-performance computing. Being at Oak Ridge, that's just a natural question for me to come across. I work every day with people who are using some of the world's fastest supercomputers in order to solve the same types of problems that we think quantum computers would be best at. So, for me, the intersection between those two areas just seems like a natural path to go down.

Black: I see. Are there any other topics related to all this that you'd like to add?

Humble: I think that quantum computing has a certain mystique around it. It's an exciting area and it relies on a field of physics that many people don't yet know about, but I certainly anticipate that in the future that's going to change. This is a topic that is probably going to impact everyone's lives. Maybe it's ten years from now, maybe it's 20 years, but it's certainly something that I think we should start preparing for in the long term, and Oak Ridge is really happy to be one of the places that is helping to lead that change.

Black: Thanks so much for your time. It was great to talk with you.

Humble: Thanks so much, Doug. It was great to talk with you, too.

About Hyperion Research, LLC

Hyperion Research provides data-driven research, analysis and recommendations for technologies, applications, and markets in high performance computing and emerging technology areas to help organizations worldwide make effective decisions and seize growth opportunities. Research includes market sizing and forecasting, share tracking, segmentation, technology and related trend analysis, and both user & vendor analysis for multi-user technical server technology used for HPC and HPDA (high performance data analysis). We provide thought leadership and practical guidance for users, vendors and other members of the HPC community by focusing on key market and technology trends across government, industry, commerce, and academia.

Headquarters

365 Summit Avenue
St. Paul, MN 55102
USA
612.812.5798
www.HyperionResearch.com and www.hpcuserforum.com
