

Practical Adiabatic Quantum Computing: A New Capability for the Test and Evaluation Community

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ABSTRACT

The Test and Evaluation community has as great a need for improved computing capabilities as any research discipline in America today. Despite the manifest approach to the limits of transistor-based CPUs, there remains a general expectation of improved computational performance. Quantum Computing is advanced by many as the next major breakthrough that will satisfy those expectations. The adiabatic form of quantum computing has advanced from theory to practice in only fourteen years. The authors report early results of more than three year's experience on an Adiabatic Quantum Annealer at the University of Southern California – Lockheed Martin Quantum Computing Center, located at USC's Information Sciences Institute (ISI). This represents the emergence of a new age of Quantum Computing, which has the potential for overcoming heretofore intractable computational challenges, thereby improving computer analysis of large data set, enhancing assessment support, and enabling innovative data management. The paper first describes quantum annealing and the theoretical orders of magnitude improvements it may deliver. It then outlines the D-Wave installation at ISI and gives examples of early results. Using these data as foundations, the potential in the realm of DoD Test and Evaluation is discussed, based on the authors' extensive experience with varying problems in verifying computer code reliability. The authors rely on their decades of research and operations in High Performance Computing, as well as their experience with the promise and the limits of technologies such as GPUs and Cell Processors, to give an objective over-view of what the members of the Test and Evaluation community should realistically expect from this new capability. They discuss a range of the test and evaluation problems that should be amenable to this new technology and forthrightly list a few areas that they believe will not benefit from the various types of Quantum Computing. Real data will be adduced to support their conclusions and to substantiate their predictions and timelines.

ABOUT THE AUTHORS

DAN M. DAVIS is a consultant for the Information Sciences Institute, University of Southern California, focusing on large-scale distributed DoD simulations. His service there was capped by his being the Director of the JESPP project for a decade. Earlier, as Assistant Director of the Center for Advanced Computing Research at Caltech, he managed Synthetic Forces Express, bringing HPC to DoD simulations. Prior experience includes serving as a Director at the Maui High Performance Computing Center and as a Software Engineer at the Jet Propulsion Laboratory and Martin Marietta. He has served as the Chairman of the Coalition of Academic Supercomputing Centers and has taught at the undergraduate and graduate levels. As early as 1971, Dan was writing programs in FORTRAN on one of Seymour Cray's CDC 6500's. He saw duty in Vietnam as a USMC Cryptologist and retired as a Commander, Cryptologic Specialty, U.S.N.R. He received B.A. and J.D. degrees from the University of Colorado in Boulder.

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Director of High Performance Computing Research for NERSC at LBNL, the Deputy Director of DARPA's ITO, and a researcher at the Institute for Defense Analyses, supporting the National Security Agency. Dr. Lucas earned BS, MS, and PhD degrees in Electrical Engineering from Stanford University.

DANIEL P. BURNS is a lifelong Systems Engineer first with the Active Duty Navy, then with a Fortune 250 Company and small business as well as in Academia. He formerly served as Naval Chair and a Professor of Practice in the Department of Systems Engineering at the Naval Postgraduate School (NPS) in Monterey California. He is a retired Captain in the United States Navy and has served as the as the Military Associate Dean and as acting Dean of the Graduate School of Engineering and Applied Sciences at NPS. For eight years he directed research as a senior executive at SAIC. His research interests center on analyses of both human and resource utilization in defense efforts. Captain Burns received a BS degree from the U.S. Naval Academy and an MS from the Naval Postgraduate School. He is currently finishing his dissertation for a PhD from Southern Methodist University.