New Opportunities for PODC? Massive, Volatile, but Highly Predictable Resources

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ABSTRACT

Classical models for distributed systems focus on fine-grained resources and failures (e.g. single processes and fail-stop or byzantine). Cheap hardware, the rise of the worldwide web, and now the rise of cloud computing has transformed distributed systems practice. Instead of single resources, application sites have ten-thousands of virtual machines, and in addition to independent failures, there are a raft of correlated failure modes.

Motivated by the reality the computing is the fastest growing consumer of electric power (and associated carbon emissions), we are creating new model for cloud computing systems, Zero-carbon Cloud, that taps a growing phenomenon of “stranded power” -- energy that is generated, but has no economic value. Stranded power is significant today (7.7 terawatt-hours in the Midwest power grid in 2014, perhaps 50 TWH worldwide), and growing rapidly as concerns about climate change drive a conversion of the grid to intermittent renewable energy generation such as wind and solar.

Zero-carbon cloud resources have several novel properties. First, they have correlated availability at massive scale – 10K-1M cores in an entire data center will go on or offline at once. Second, these periods may be highly predictable -- external factors such as weather, predicted load, and power markets shape the availability of stranded power. Third, these properties can be engineered – for example, a small amount of energy storage can be used to “delay” unavailability.

We will propose Zero-carbon cloud, or massive volatile resources based on stranded power as an interesting new model for a variety of classical distributed systems challenges (consistency, etc.) and new challenges for optimization.

More information is available at <http://zccloud.cs.uchicago.edu/>

Brief Biography

Dr. Andrew A. Chien is the William Eckhardt Distinguished Service Professor in Computer Science, Director of the CERES Center for Unstoppable Computing, and Senior Fellow in the Computation Institute at the University of Chicago. He also serves as a Senior Computer Scientist at the Argonne National Laboratory. Dr. Chien served as Vice President of Research at Intel Corporation, leading long-range and “disruptive technologies” research at Intel Research. At Intel, he also led Intel’s external research programs, including government and

higher education engagements. In this role, Chien launched imaginative new efforts in robotics, wireless power, sensing and perception, nucleic acid sequencing, networking, cloud, and ethnography. Working with Microsoft and NSF, Chien was instrumental in creation of the Universal Parallel Computing Research Centers (UPCRC) focused on parallel software, the Open Cirrus Consortium focused on Cloud computing, and Intel’s Exascale Research program.

For more than 25 years, Chien has been a global research and education leader, and an active researcher in parallel computing, computer architecture, programming languages, networking, clusters, grids, and cloud computing. Previous academic positions include the SAIC Chair Professor in Computer Science and Engineering, and founding Director of the Center for Networked Systems at the University of California at San Diego (1998-2005). While at UCSD, he also founded Entropia, a widely-known Internet Grid computing startup. From 1990 to 1998, Chien was a Professor of Computer Science at the University of Illinois at Urbana-Champaign with joint appointments at the National Center for Supercomputing Applications (NCSA) where he was a research leader for parallel computing software and hardware, and developed the well-known Fast Messages, HPVM, and Windows NT Supercluster systems.

Dr. Chien is a Fellow of the American Association for Advancement of Science (AAAS), Fellow of the Association for Computing Machinery (ACM), Fellow of Institute of Electrical and Electronics Engineers (IEEE), and has published over 150 technical papers. His research has been recognized for excellence, and supported by the National Science Foundation (NSF), Defense Advanced Research Projects Administration (DARPA), Department of Energy (DOE), National Aeronautics and Space Agency (NASA), Office of Naval Research (ONR), and numerous industry sponsors. Chien served on the Board of Directors for the Computing Research Association (CRA), Advisory Board of the National Science Foundation’s Computing and Information Science and Engineering (CISE) Directorate, and is currently on the Editorial Board of the Communications of the Association for Computing Machinery (CACM), ACM’s Transactions on Parallel Computing (TOPC), and the Journal of Grid Computing (JOGC). Chien received his Bachelor’s in electrical engineering, Master’s and Ph.D. in computer science from the Massachusetts Institute of Technology.

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