Departmental Colloquium
Electrical and Computer Engineering

MARQUETTE UNIVERSITY

A Probabilistic Model to Predict the Impact of Rare and Colossal Interference in HPC Systems

Tuesday, February 27, 2024
2:00 pm – 3:00 pm
Olin 202

Reception to follow in Olin 204
3:00 pm – 3:30 pm

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ABSTRACT: Understanding and predicting the performance of HPC applications are crucial for their performance optimization through task scheduling and load balancing. However, optimizing the HPC application is usually a challenging task in the presence of rare and colossal interference, which causes major slowdowns. Interference is caused by interaction between the HPC application and other system activities or other applications. Such interference impedes the application's performance especially if it occurs rarely (low frequency) yet over long durations. The performance of the HPC application is usually assessed using the interval length, which is determined by the maximum execution time across the many processors involved in large-scale parallel computations. Most of the available probabilistic models for the interval length fail to capture the characteristics of rare and colossal interference in HPC systems. In particular, they fail to accurately predict the mean interval length at scale, thereby underestimating the adverse impact of such interference at scale. In this presentation, I will introduce, based on the doctoral work of my student Muna Tageldin, a composite probabilistic approach that characterizes interference and workload independently. Through this composite model, we can characterize rare and colossal interference and predict its impact on the application's performance. This model offers an efficient computational tool, using asymptotic analysis, extreme-value theory, and large-deviation theory, to characterize not only the mean interval length but also the tail of its distribution at scale as the number of processors increase. The efficacy of our approach is evaluated using synthetic HPC application data that depict rare and colossal interference, as well as a case study from a production HPC system. The results show that the proposed probabilistic model accurately estimates the interval-length characteristics at scale.

BIOGRAPHY: Dr. Hayat received his Bachelor of Science (summa cum laude) in Electrical Engineering from the University of the Pacific (in Stockton, CA) in 1985. He received the M.S. and the Ph.D. degrees in Electrical and Computer Engineering from the University of Wisconsin-Madison in 1988 and 1992, respectively. He is currently a Professor and Department Chair of Electrical and Computer Engineering at Marquette University. His research activities cover a broad range of topics including resilience and reliability of interdependent cyberphysical systems, dynamical modeling of cascading phenomena with applications to resilient power systems, avalanche photodiodes, statistical communication theory, signal and image processing, algorithms for spectral and radar sensing and imaging, optical communication, and networked computing. Dr. Hayat is a Fellow of IEEE, OSA, SPIE and OPTICA.