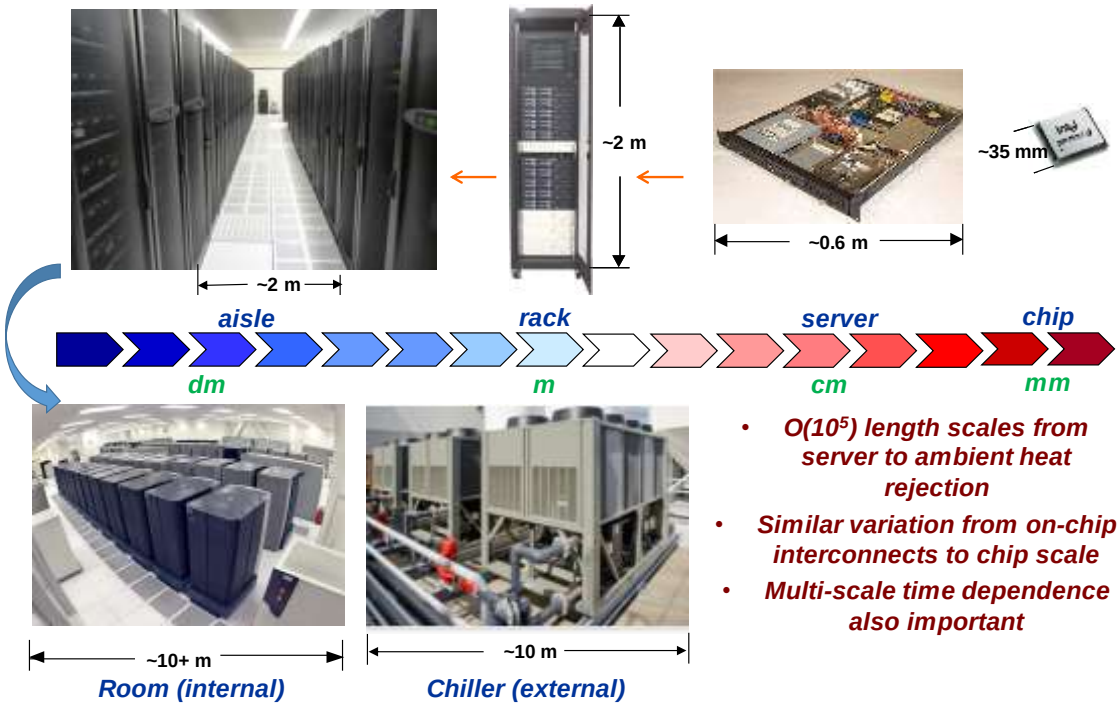
Multi-scale Computations and Experimental Validations

for Thermal Management of Data Centers

Data centers currently consume nearly 3% of the generated electricity in the United States and globally, of which 20%-50% is towards thermal management. With continuing growth of these facilities, it is critical to insure their energy efficient thermal management. The computing hardware in data centers must be efficiently cooled for reliability, while optimizing for minimal energy consumption. Air cooling at the data center facility level continues to be widely used, even as high performance liquid based chip cooling approaches emerge, and are integrated. Characterizing and managing air flows in data centers to insure adequate cooling and energy efficiency, in the presence of varying workloads is a key challenge. Integration of liquid cooling technologies within data centers is also gaining significant interest. Computational techniques play an important role in understanding the temperature distributions and hot spots within data centers.



This short course will present selected advances in data center thermal management. These advances, primarily from the speakers' own research, will cover the following topics:

1. Issues in thermal management of data centers

2. Multiscale computation of data center cooling using commercial and in-house software

3. Multigrid acceleration of data center CFD

4. Parallel CFD computing using Graphics processing units (GPU)

5. Experiments and Machine Learning for Data center thermal management

Biographical Sketches of Instructors:

PRATAP VANKA
University of Illinois at Urbana-Champaign

Pratap Vanka is Professor Emeritus and Research Professor in the Department of Mechanical Science and Engineering. He has pioneered several numerical algorithms including multigrid methods, Lattice Boltzmann methods, meshless techniques, GPU computing, and partially-parabolic methods. He has taught a graduate level CFD course at University of Illinois for 25 years, and continues to teach that course after taking Emeritus status. He is passionate about developing codes for CFD and heat transfer and has developed more than 25 research level CFD codes since his graduate research at Imperial College. He worked for his Ph. D. with Professor D.B. Spalding, a pioneer in computational fluid dynamics and computational heat transfer. Pratap Vanka has published close to 170 papers in journals and reviewed technical conferences. He has received both teaching and research awards. He is Fellow of ASME, Fellow of APS, Associate Fellow of AIAA, and recipient of the ASME Freeman Scholar lecture award.

YOGENDRA JOSHI
Georgia Institute of Technology

Yogendra Joshi is Professor and John M. McKenney and Warren D. Shiver Distinguished Chair at the G.W. Woodruff School of Mechanical Engineering at the Georgia Institute of Technology. His research interests are in multi-scale thermal management. He is the author or co-author of nearly four hundred publications in this area, including nearly two hundred journal articles. He received his B. Tech. in Mechanical Engineering from the Indian Institute of Technology (Kanpur) in 1979, M.S. in Mechanical Engineering from the State University of New York at Buffalo in 1981, and Ph.D. in Mechanical Engineering and Applied Mechanics, from the University of Pennsylvania in 1984. He has held visiting faculty appointments at Stanford University, Katholieke Universiteit Leuven, and Xi'an Jiaotong University. He is an elected Fellow of the ASME, the American Association for the Advancement of Science, and IEEE. He was a co-recipient of ASME Curriculum Innovation Award (1999), Inventor Recognition Award from the Semiconductor Research Corporation (2001), the ASME Electronic and Photonic Packaging Division Outstanding Contribution Award in Thermal Management (2006), ASME J. of Electronics Packaging Best Paper of the Year Award (2008), IBM Faculty Award (2008), IEEE SemiTherm Significant Contributor Award (2009), IIT Kanpur Distinguished Alumnus Award (2011), ASME InterPack Achievement Award (2011), ITherm Achievement Award (2012), ASME Heat Transfer Memorial Award (2013), and AIChE Donald Q. Kern Award (2018).