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Design and Stability of Load-side Frequency Control

Abstract:
Frequency control maintains the frequency of a power system tightly around its nominal value when demand or supply fluctuates. It is traditionally implemented on the generation side though load-side participation can offer advantages in fuel, emission, and responsiveness. We present a systematic method to design ubiquitous continuous fast-acting distributed load control for frequency regulation, by formulating an optimal load control (OLC) problem where the objective is to minimize the aggregate cost of tracking an operating point subject to power balance over the network. We prove that the swing dynamics and the branch power flows, coupled with frequency-based load control, serve as a distributed primal-dual algorithm to solve OLC. We establish the global asymptotic stability of a multimachine network under such type of load-side frequency control. These results imply that the local frequency deviations on each bus convey exactly the right information about the global power imbalance for the loads to make individual decisions that turn out to be globally optimal.

(Joint work with Changhong Zhao, Ufuk Topcu (UPenn), and Lina Li (MIT/Harvard)

Bio:
Steven H. Low is a Professor of the Computing & Mathematical Sciences and Electrical Engineering Departments at Caltech. Before that, he was with AT&T Bell Laboratories, Murray Hill, NJ, and the University of Melbourne, Australia. He was a co-recipient of IEEE best paper awards, the R&D 100 Award, and an Okawa Foundation Research Grant. He is on the Technical Advisory Board of Southern California Edison. He is a Senior Editor of the IEEE Journal on Selected Areas in Communications, a Senior Editor of the IEEE Trans. Control of Network Systems, a Steering Committee Member of the IEEE Trans. Network Science & Engineering, and on the editorial board of NOW Foundations and Trends in Networking, and in Power Systems. He is an IEEE Fellow and received his B.S. from Cornell and PhD from Berkeley, both in EE.