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THE CHINESE UNIVERSITY OF HONG KONG

Department of Information Engineering

Seminar

Online Optimization of Power Networks

by

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Date : 25 April, 2016 (Monday)

Time : 3:00pm – 4:00pm

Venue : Room 833, Ho Sin Hang Engineering Building
The Chinese University of Hong Kong

Abstract

We are at the cusp of a historical transformation of our power systems into a more sustainable, dynamic, intelligent, and distributed form with hundreds of millions of intelligent endpoints. The optimization and control of such a network requires solving power flow equations which is well-known to be hard. The grid, however, solves them in real-time at scale, and we propose to exploit it explicitly to carry out part of our optimization algorithm. This approach not only improves scalability, but also naturally adapts to evolving network conditions. In this talk, we present two examples.

The first example presents an online algorithm to solve an optimal power flow problem at a slow timescale on a radial network where the controllable devices continuously interact with the network that implicitly computes a power flow solution given a control action. Collectively these devices and the network implement a gradient projection algorithm in real time. We prove that the proposed algorithm converges to a set of local optima and provide sufficient conditions under which it converges to a global optimum. We derive an upper bound on the suboptimality gap of any local optimum. This bound suggests that any local optimum is almost as good as any strictly feasible point.

In the second example, the online algorithm integrates primary frequency regulation, secondary frequency regulation, and congestion management at a fast timescale. The algorithm is distributed in that it requires communication only between neighboring buses. Collectively, the controllable devices and the swing dynamics of the network implement a primal-dual algorithm to rebalance power, restore nominal frequency and inter-area flows, and enforce line limits at a minimum control cost. We prove sufficient conditions under which the algorithm converges to a global optimum.

Biography

Steven H. Low is a Professor of the Department of Computing & Mathematical Sciences and the Department of Electrical Engineering at Caltech. Before that, he was with AT\&T Bell Laboratories, Murray Hill, NJ, and the University of Melbourne, Australia. He was on the Technical Advisory Board of Southern California Edison and a member of the Networking and Information Technology Technical Advisory Group for the US President's Council of Advisors on Science and Technology (PCAST) in 2006. He is a Senior Editor of the IEEE Transactions on Control of Network Systems and the IEEE Transactions on Network Science & Engineering, is on the editorial boards of NOW Foundations and Trends in Networking, and in Electric Energy Systems, as well as Journal on Sustainable Energy, Grids and Networks. He received his B.S. from Cornell and PhD from Berkeley, both in EE. He is an IEEE Fellow.

**** ALL ARE WELCOME ****

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