Title:
Controller Architectures: Tradeoffs between Performance and Complexity

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Abstract:
This talk describes the design of controller architectures that achieve a desired tradeoff between performance of distributed systems and controller complexity. Our methodology consists of two steps. First, we design controller architecture by incorporating regularization functions into the optimal control problem and, second, we optimize the controller over the identified architecture. For large-scale networks of dynamical systems, the desired structural property is captured by limited information exchange between physical and controller layers and the regularization term penalizes the number of communication links. In the first step, the controller architecture is designed using a customized proximal augmented Lagrangian algorithm. This method exploits separability of the sparsity-promoting regularization terms and transforms the augmented Lagrangian into a form that is continuously differentiable and can be efficiently minimized using a variety of methods. Although structured optimal control problems are, in general, nonconvex, we identify classes of convex problems that arise in the design of symmetric systems, undirected consensus and synchronization networks, optimal selection of sensors and actuators, and decentralized control of positive systems. Examples are provided to demonstrate the effectiveness of the framework.