



CPS: Medium: Collaborative Research: Demand Response & Workload Management for Data Centers with Increased Renewable

CPS Awards 1739344,1739189, 1739355 (09/2017-); Junshan Zhang and Lei Ying (ASU), R. Srikant (UIUC) and Steven Low (Caltech)

Challenge:

- Decarbonization is one of most pressing challenge in humanity in 21st century
- In power grid, it means to add more wind/solar/hydro; smart grid will evolve into largest and most complex IoT
- Need to strike a balance between supply & demand at a times, but supply/demand vary frequently and randomly,

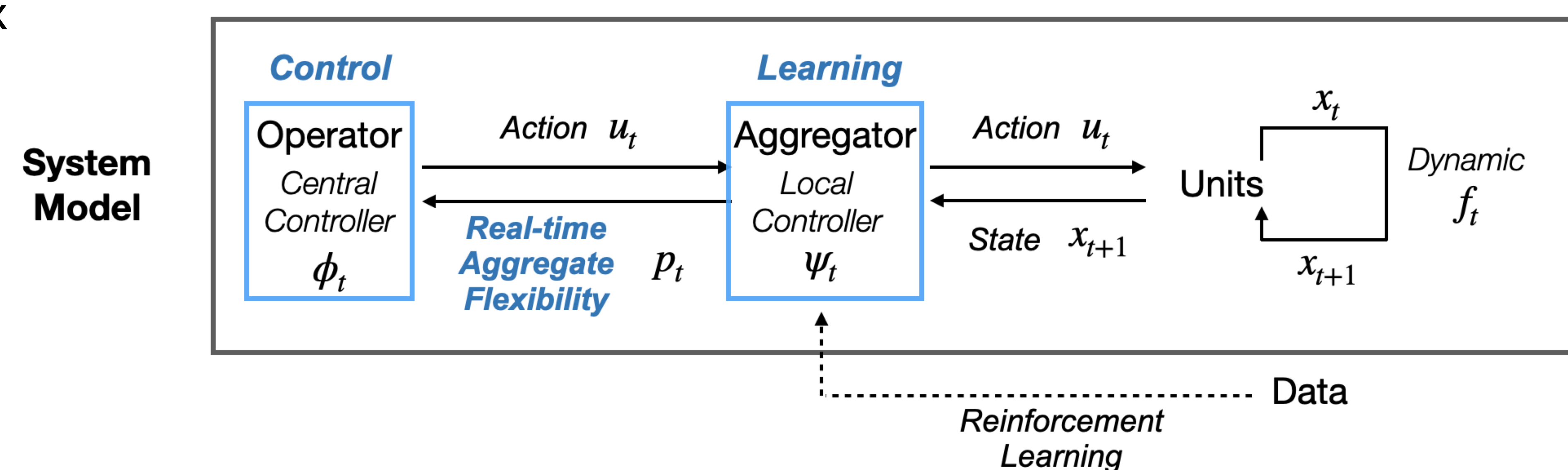
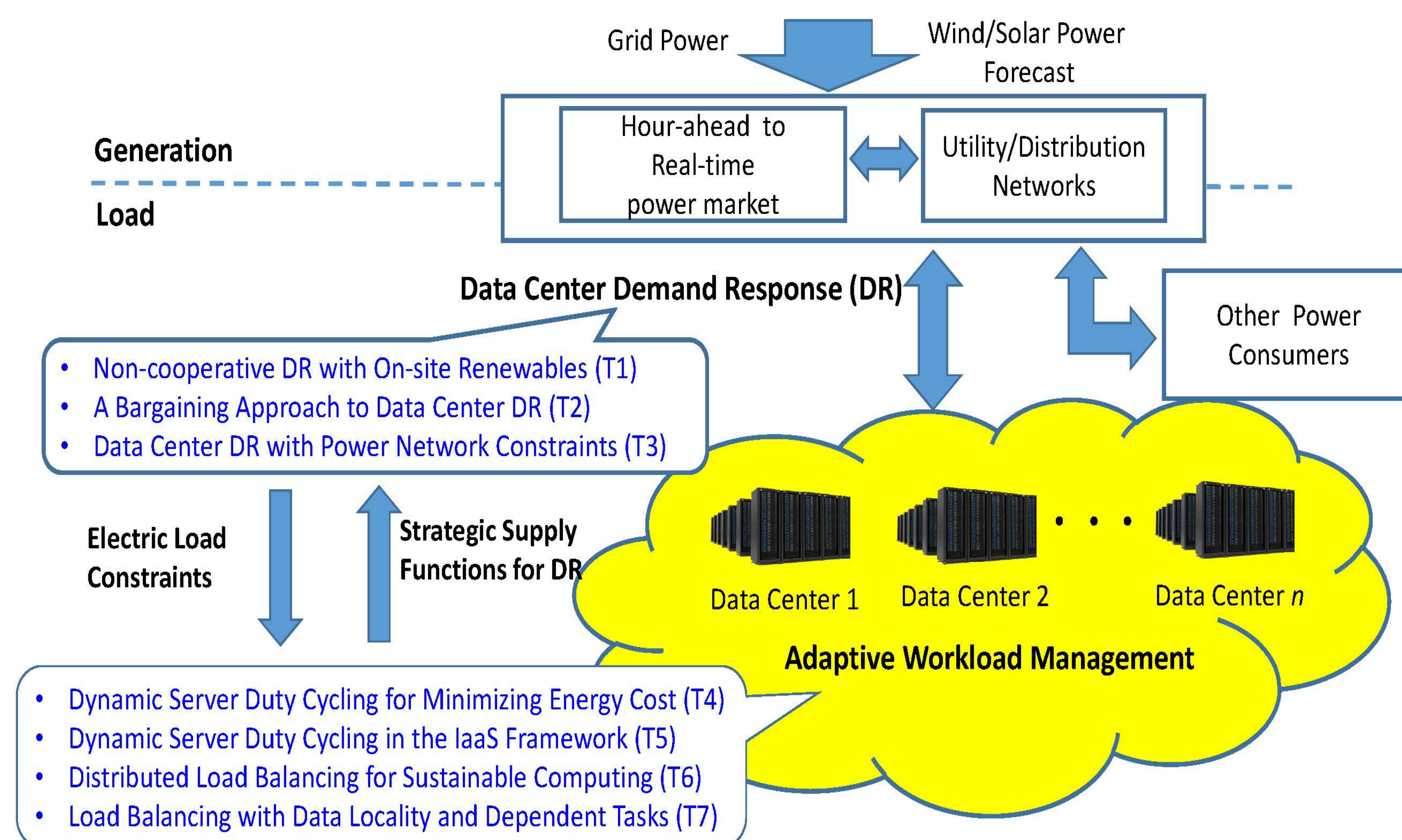
Solution:

I) Data center demand response: Data centers offer large electric load, have more market power and can be strategic players in energy market

- Existing approach: passive price -taker;
- Our approach: a bargaining approach for data center DR

II) Developed algorithms for time-varying nonconvex optimization with provable guarantee on tracking error and applied them to real-time feedback-based AC OPF problems; distributed algorithms for DER-based frequency control of multi-area power grid with provable guarantee on satisfaction of operational constraints and line limits

III) Load balancing: Established a university scaling of queue-length distributions of large-scale data centers under a general class of load balancing algorithms; provided sufficient conditions for achieving zero waiting for incoming jobs.



Scientific Impact:

- 1) New market programs with strategic participation of data centers in DR
- 2) Fundamental understanding of the impacts of power network constraints on data center DR
- 3) High-performance dynamic server provisioning and load balancing algorithms for large scale data centers under time-varying and stochastic electric load constraints and on-site renewable generation.
- 4) Two successful startups (Smartiply Inc and Powerflex Inc)

Broader Impact:

- Power blackout could result in massive load shedding: e.g., economic impact in Texas winter storm blackout - \$130 Billion (Dallas News) and 69 deaths (AP); larger impact on poorer socio-economic communities
- Demand response is a paradigm shift and adjusts **Demand** to follow **Supply**
- Ultimate goal: to achieve a **carbon neutral electric energy grid** that seamlessly meets the required safety, reliability, economy, and resiliency expectations of critical national infrastructures while fostering the development of a diverse workforce to support this national goal

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