

Information and Computation Structures for the Smart Grid



Lang Tong, Salman Avestmehri, Elyan Bitar, Kevin Tang, and Aaron Wagner, Cornell University
Pete Sauer, The University of Illinois, Urbana-Champaign

Fundamental questions:

- Are existing computation, communication, and networking infrastructures adequate for a future smart grid?
- What types of information and computation structures are required?

Importance for the future grid

A fundamental understanding of information hierarchy is essential to meet new challenges due to

- the greater penetration of variable/intermittent sources and dynamic loads;
- Increasing needs of grid efficiency and flexibility through wide area sensing and control;
- more sophisticated demand response and dynamic pricing;
- greater security risks and reliability challenges for smart grids as large cyber physical systems.

Principal issues:

Computation, communication, and networking architecture

- **Layered networking architecture** for real-time and delay sensitive operations.
 - Roles of topology and traffic elasticity
 - The need of cooperation among intermediate nodes
- **Wireless infrastructures** that facilitate intelligent peripherals for distributed information exchange, learning, adaptation, and control
 - impacts of scalability and rich bidirectional communication needs
 - role of wireless network heterogeneity in smart grid
- **Cloud platform & smart grid**
 - data centers and massive parallel computation
 - From a few control centers to millions of users

Space-time information hierarchy

- Value of Information in multi-time scale forecast, sensing, and scheduling.
- Intelligent peripherals with message passing architecture for decentralized decisions and coordinated response.
- Roles of compression in Information fusion, aggregation, and feedback.

Principal issues:

Cyber-physical security and reliability

- Cyber-enabled attacks on the grid and market functions.
- Mechanism failures and instability.
- Fault detection and prediction

Suggested paths:

Research:

- consistent investment in fundamental, long term, and multidisciplinary research across power systems engineering, information technology, and applied economics.

Industry-academia collaborations:

- Establishing GOALI (NSF) and CORDIS (EU) like programs that support faculty on leave in industry and government labs.
- Providing fundamental research support to industry sponsored research centers (e.g. PSerc).