Self-Aware Communication and Signal Processing Systems: Real-Time Adaptation to Power, Error Resilience and Workload Demands

Abhijit Chatterjee
School of Electrical and Computer Engineering, Georgia Institute of Technology. Atlanta, GA, USA

Real-time systems for wireless communication and digital signal processing experience a wide gamut of operating conditions (signal/channel noise, workload demand, perturbed process conditions). As device bandwidths expand, it becomes increasingly expensive, from a power consumption and reliability perspective, to operate such real-time systems for worst-case (static) performance requirements. In contrast, it is attractive to design "self-aware" algorithms, architectures and circuits that are power-performance tunable and can adapt dynamically to the requirements of system-level applications for extended battery usage and device lifetime. Such future systems will feed application level demands to the underlying algorithm-architecture-circuit design fabric through built-in sense-and-control infrastructure (hardware, software). The sense functions assess instantaneous application level demands (e.g. throughput, signal integrity) as well as the performances of the individual hardware components as determined by manufacturing process conditions. The control functions actuate algorithm-through-circuit level tuning knobs that continuously trade off performance vs. power of the individual software and hardware modules in such a way as to deliver the end-to-end desired application level Quality of Service (QoS), while minimizing energy/power consumption. A distributed video sensing system is used as an example to demonstrate the core ideas. Adaptation methods for SISO and MIMO systems are presented and control subsystem design using constrained optimization, fuzzy control and self-learning is discussed.