Research Challenges in Temperature-Aware Design

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Motivation

- High power densities → high temperatures
  - Decreasing form factors, tight packing
  - Power supplies, disks (especially arrays), blades
  - Other sources: air flow may cause “hot spots”, emergencies (cooling failure, accidental overload)

- High temperature degrades reliability

- Cooling complexity and costs
  - Ideal: Cool for the “average” or “common” case; intelligent management, including emergencies
What we have

- Theory: Physics, Mechanical Engineering
- Few tools: temperature and CFD, HotSpot
- Few monitors: processors, disks, boards
- Mechanisms for power control
- Simple policies for thermal management
  - Blindly shut or slow server/device down
  - Generate a warning or speed fans up
What we don’t have

- **Background:** CFD, relationship to reliability

- **System-level simulation tools**
  - Run application programs and operating systems
  - Simulate cooling failures, thermal overload, layouts

- **Better monitoring**
  - More thermal and air flow sensors, tachometers
  - Equivalent of processor counters for other devices?
What we don’t have

- More sophisticated management policies!
  - Temperature and reliability modeling
  - Combined temp, power, and energy management
  - Reliability-conscious resource scheduling and management
  - Temp-aware resource scheduling (e.g., disks)
  - “Quality of temp” or “Temp differentiation”
  - Temp-aware workload distribution (distr. systems)
Our Temperature Simulator
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