Designing for the Cloud

An Architect's Perspective

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Good News – Bad News

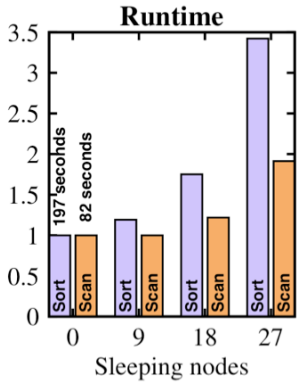
- The opportunities
  - + Lots of parallelism (request-level)
  - + Mostly focused on throughput
    - Latency often limited by WAN
  - + Room for innovation in SW & HW
    - Assuming SaaS, VMs, data-center in a box, …
- The challenges
  - – Cost sensitive, consumer systems
    - Commodity components, energy efficiency, …
  - – Large distributed systems
    - Large number of nodes, heterogeneity, ~O(1) scaling, …
  - – Efficiency across range of evolving apps and scenarios
  - – Non-stop operation
    - Availability, durability, predictability, …

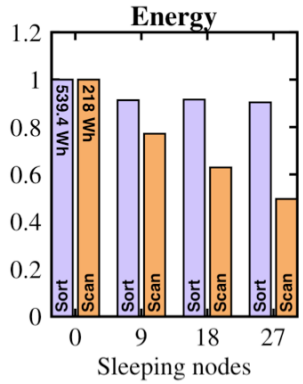
So what's an architect to do?

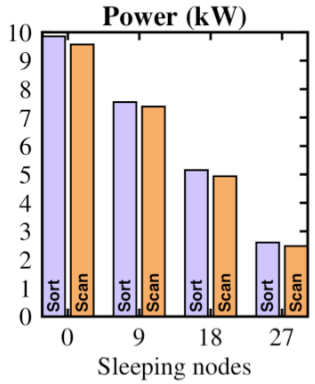
1. Design a System, not a Chip

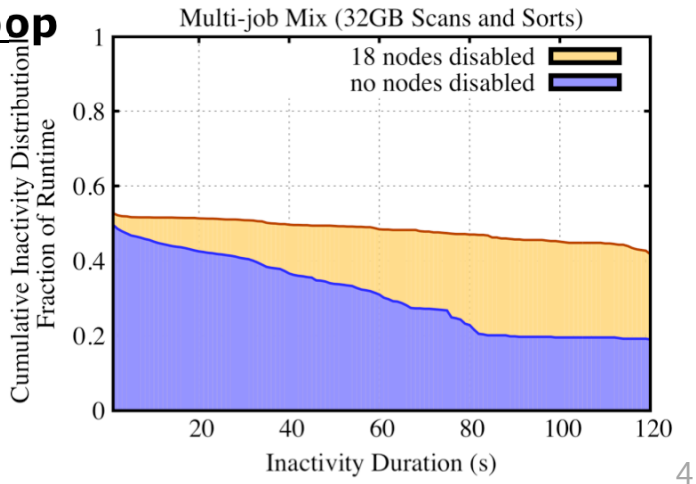
- Top-down design of middleware & HW
  - Meaningful metrics and goals
  - Focus on true bottlenecks (e.g. HW vs language efficiency)
  - Use high-level properties & system-wide techniques

- Example: assuming system-wide data replication
  - Focus on per-node error detection instead of error correction
  - Forward requests to avoid latency spikes, thermal issues, …
  - Energy proportionality by turning nodes on/off
    - E.g. results from **energy-efficient Hadoop**

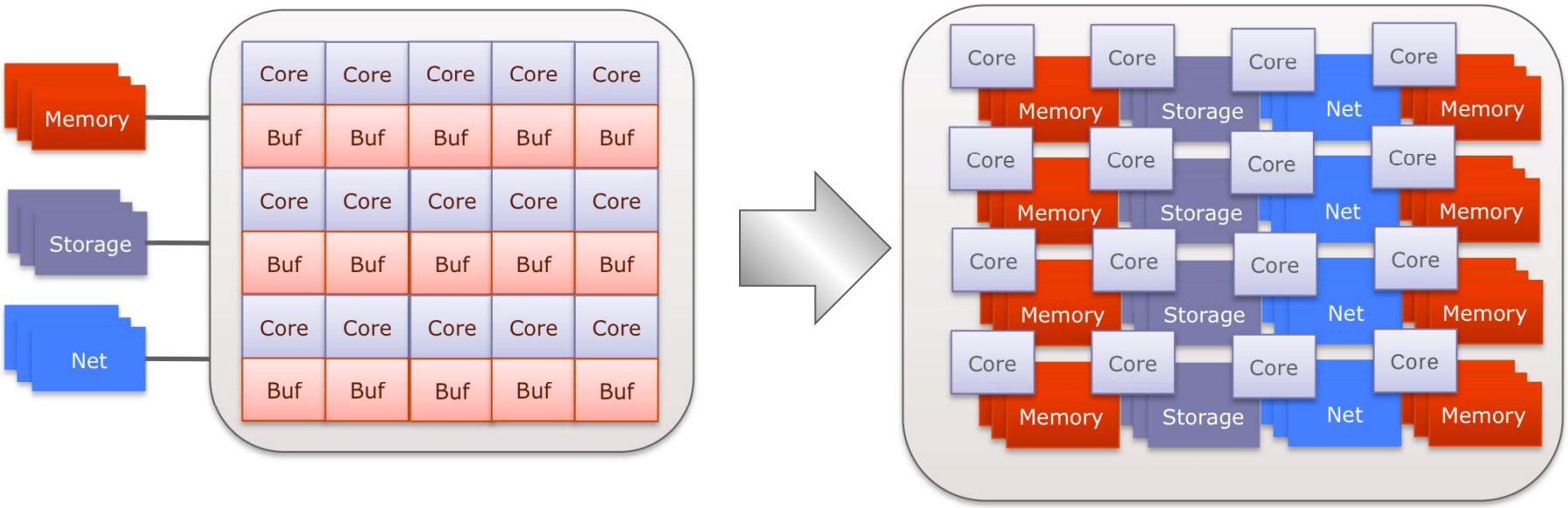








2. From Compute- to Data-Centric

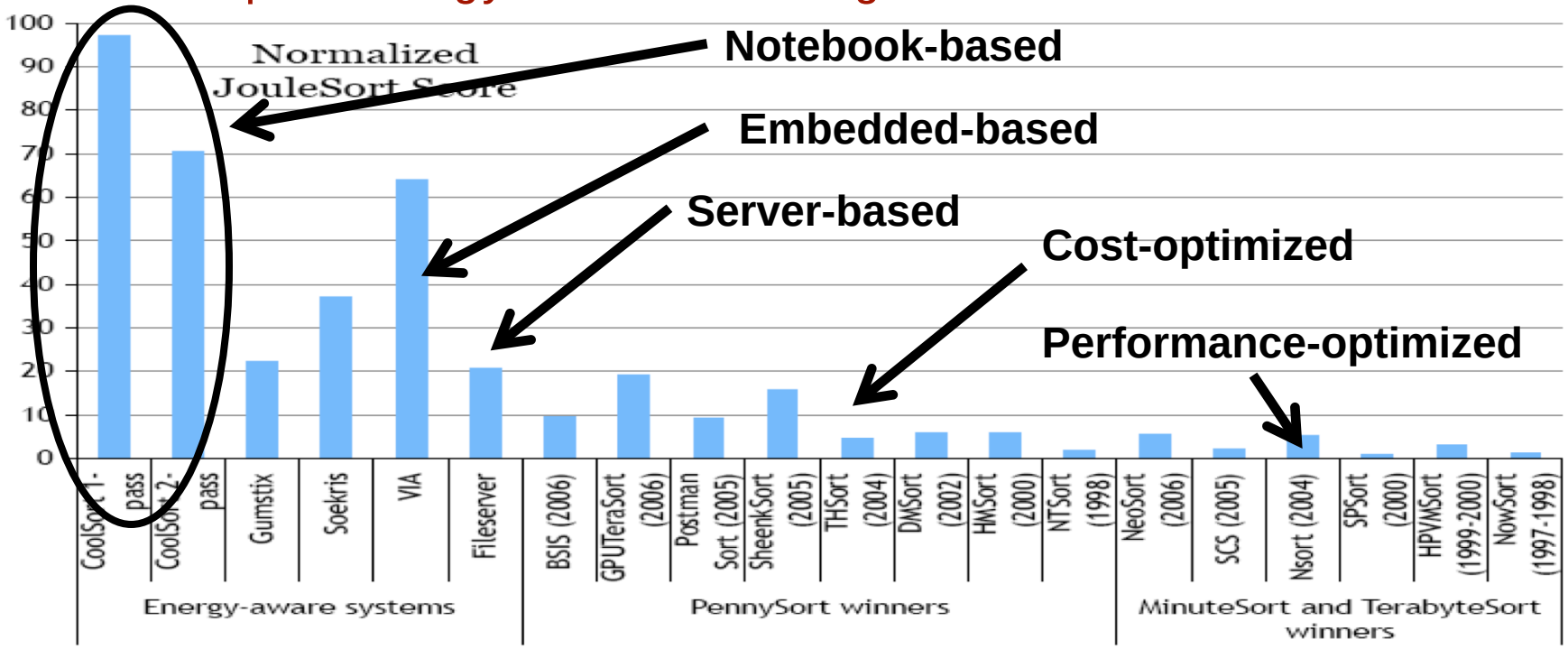


- Compute is now cheap and efficient
- Focus on memory, storage, and network
  - Throughput, latency, energy, power, …
  - Rethink arch, HW/SW interface, support for distributed ops
  - Tradeoff compute for communication

3. Rethink Components & Balance

- What are the right components for the system?
  - Server, notebook, or embedded?
  - Best way to connect them and balance their features?

- Example: energy efficient sorting



4. Tools and Methodologies

- In great need of
  - Analysis of workloads and systems
  - Models for emerging apps & architectures
  - Benchmarks (workloads and metrics)
  - Convincing prototyping techniques
  - Understanding of performance, energy, and reliability tradeoffs