CS 223 Computer Organization & Architecture

Lecture 38 [22.05.2020]

How to Explore Computer Architecture?

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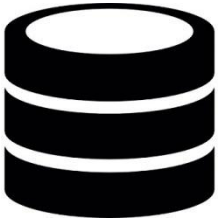
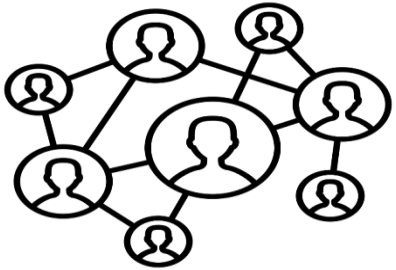
The Data problem of future

- Computing is Bottlenecked by Data
- Important workloads in AI, ML, Genomics are all data intensive
- They require rapid and efficient processing of large data
- Data is increasing : We can generate more than we can process

Data is Key for Future Workloads

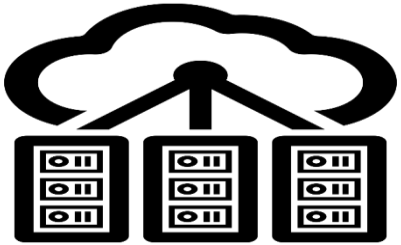


In-memory Databases



Graph/Tree Processing

In-Memory Data Analytics



Datacenter Workloads

Data → performance & energy bottleneck

Data is Key for Future Workloads

Chrome

Google's web browser

TensorFlow Mobile

Google's machine learning framework

VP9

YouTube

Video Playback

Google's video codec

VP9

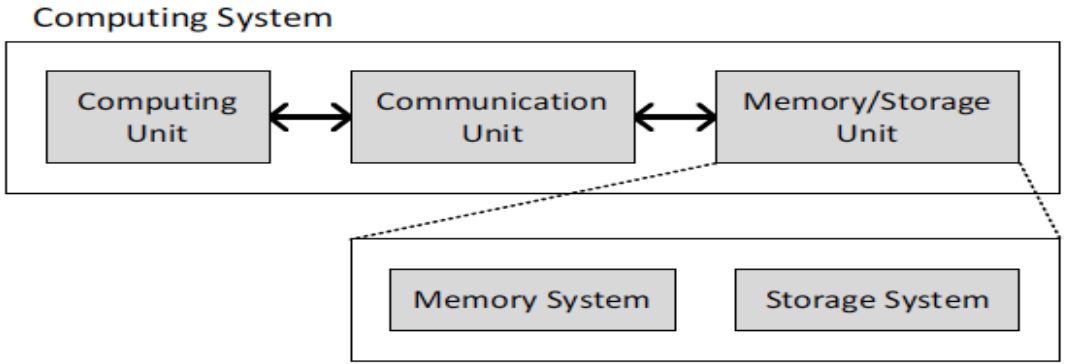
YouTube

Video Capture

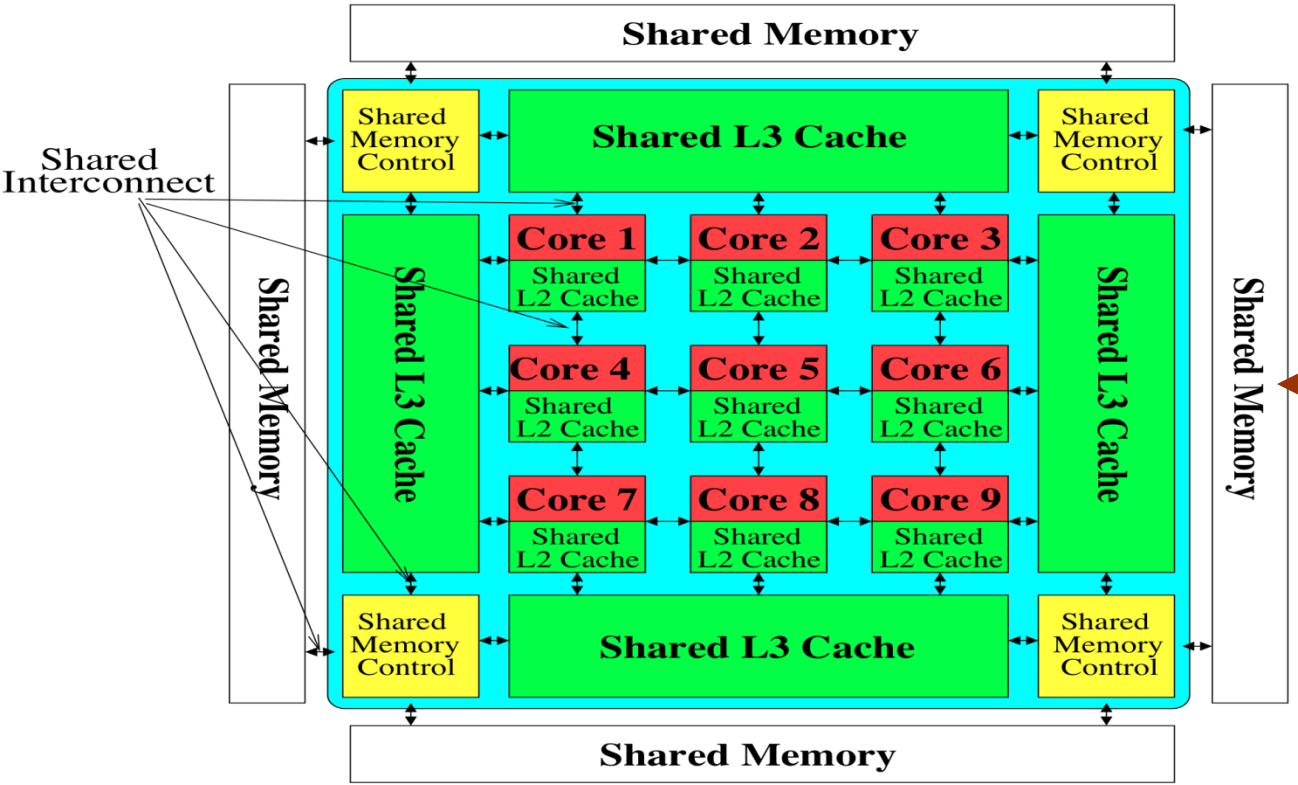
Google's video codec

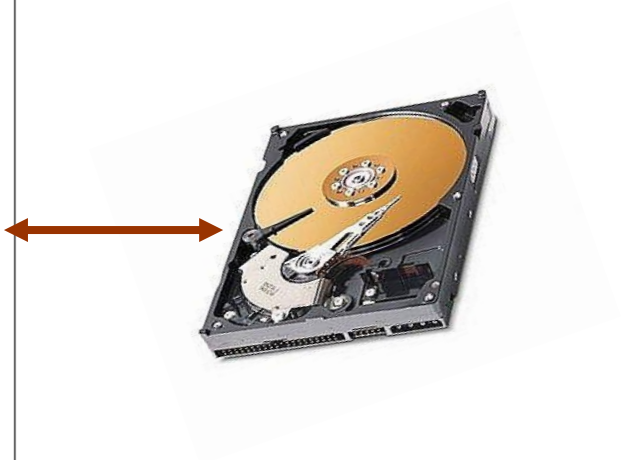
Pillars of Modern Machines

- Storage/memory capability
- Communication capability
- Computation capability
- Greatly impacts robustness, energy, performance, cost



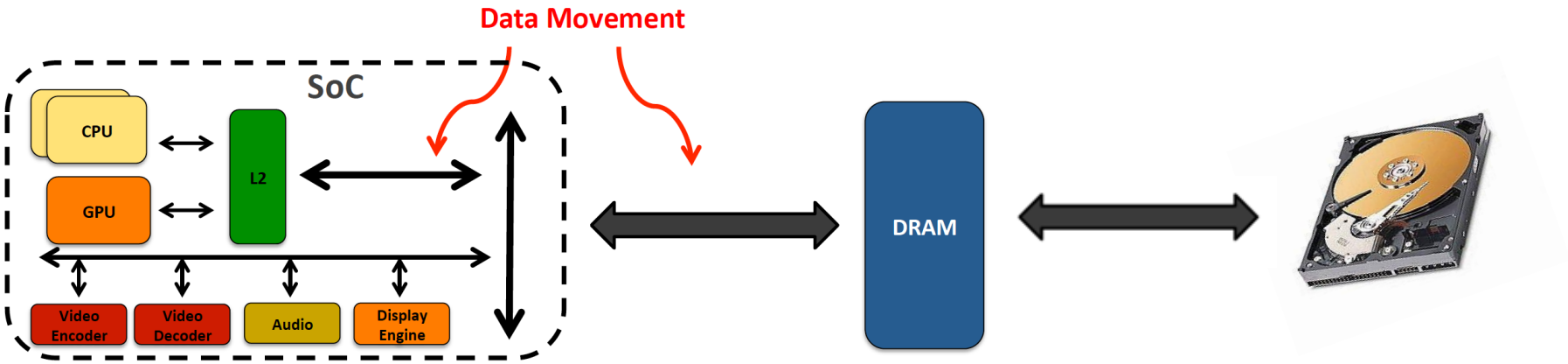
Limitations of Processor-Centric Design





Most of the system is dedicated to storing and moving data

Limitations of Processor-Centric Design



Most of the system is dedicated to storing and moving data

Handle Data Well

- Ensure data does not overwhelm the components
  - via intelligent algorithms
  - via intelligent architectures
  - via whole system designs: algorithm-architecture-devices
- Take advantage of vast amounts of data and metadata
  - to improve architectural & system-level decisions
- Understand and exploit properties of (different) data
  - to improve algorithms & architectures in various metrics

Data-Centric Architectures

- **Process data where it resides**
  - Processing in and near memory structures
- **Low-latency & low-energy data access**
  - Low latency memory
  - Low energy memory
- **Low-cost data storage & processing**
  - High capacity memory at low cost: hybrid memory, compression
- **Intelligent data management**
  - Intelligent controllers handling robustness, security, cost, scaling

The Way Forward

- Data-centric system design & intelligence spread around
  - Do not center everything around traditional computation units
- Better cooperation across layers of the system
  - Careful co-design of components and layers: system/arch/device
  - Better, richer, more expressive and flexible interfaces
- Better-than-worst-case design
  - Do not optimize for the worst case, look common case
- Heterogeneity in design (specialization, asymmetry)
  - Enables a more efficient design (No one size fits all)

How to explore computer architecture ?

- Refer to IEEE/ACM transactions & journals
  - IEEE TCAD, IEEE-TVLSI, IEEE-TOC,
  - ACM-TODAES, ACM-TECS, ACM-TACO
  - JPDC, JSC, JSA, CAL, ESL
- Refer to top tier conferences
  - ISCA, HPCA, MICRO, ASPLOS, PACT, DATE, DAC, ICCAD
  - ICCD, ISVLSI, ASPDAC, VLSI-SoC, GLSVLSI, NOCS, NoCArc
  - HiPC, VLSID, VDAT, ISED

How to explore computer architecture ?

- **Familiarize open source architectural simulators**
  - **gem5, Multi2sim, Sniper, Tejas,**
  - **Booksim, DRAMSim, Usimm, GPGPUSim**
  - **Cacti, Orion**
- **Model the architecture in simulators and implement them using HDLs, Verify sub-modules in FPGA kit explore further …**

Summary

- Multicore processors and on-chip clouds are going to become an integral part of future digital technologies.
- Understanding the hardware of such system will help us to design with conceptual clarity.
- Our country need good computer architects and processor design engineers with hands on exposure to VLSI design flow to cater the growing demand of skilled personnel in this domain.

Our role as educated citizens

Let us make ourselves up-to-date in our respective subjects with latest technology enabled learning and practice healthy, sound learning and research practices, academic teamwork to mutually inspire each one of us such that we get transformed as potential technocrats, engineers, scientists, teachers and researchers of next generation.

Conclusion

Your time in educational institutes is a unique experience: Enjoy it!

It is not the destination but the journey important

Good luck and make your parents, teachers and college proud by the quality of work you produce!

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