Thinking “big” in science and genomics

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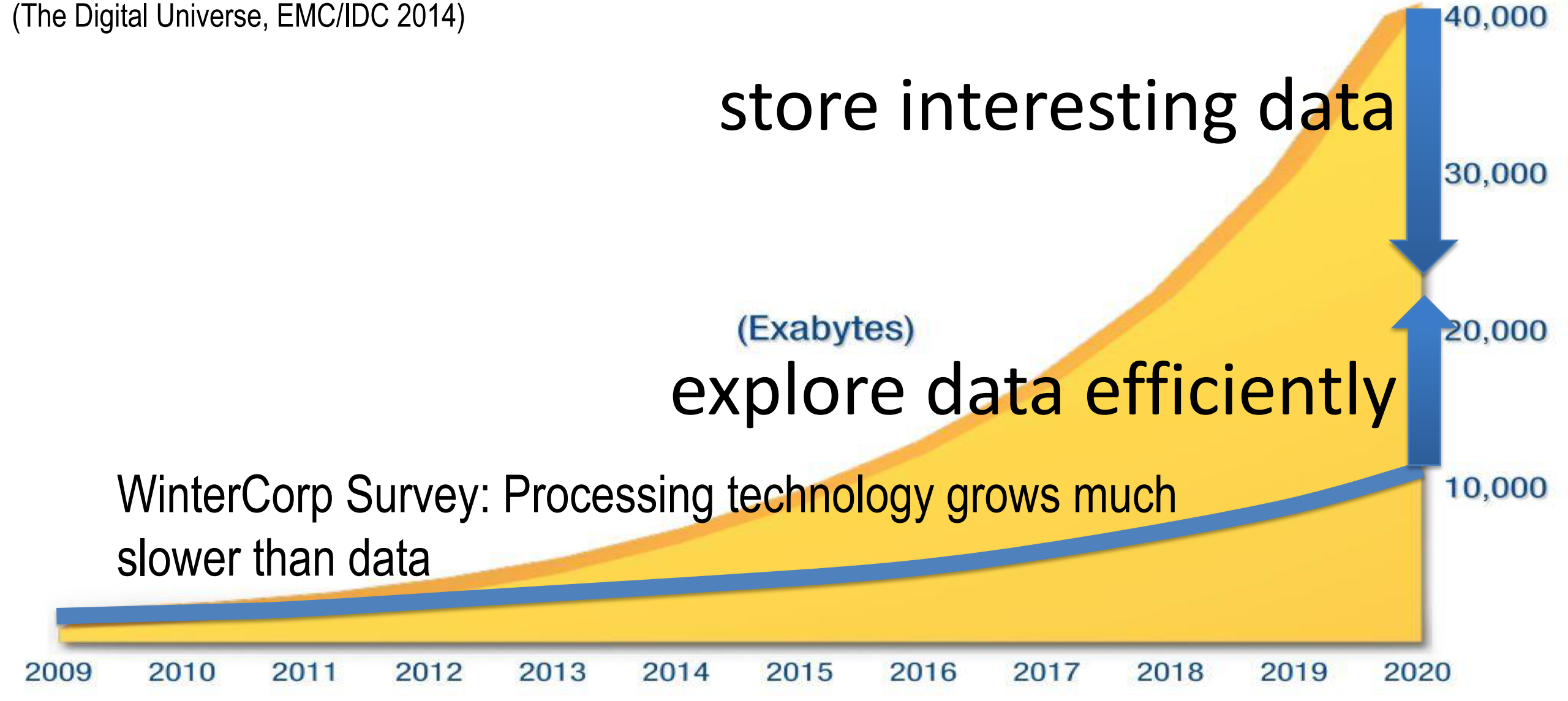
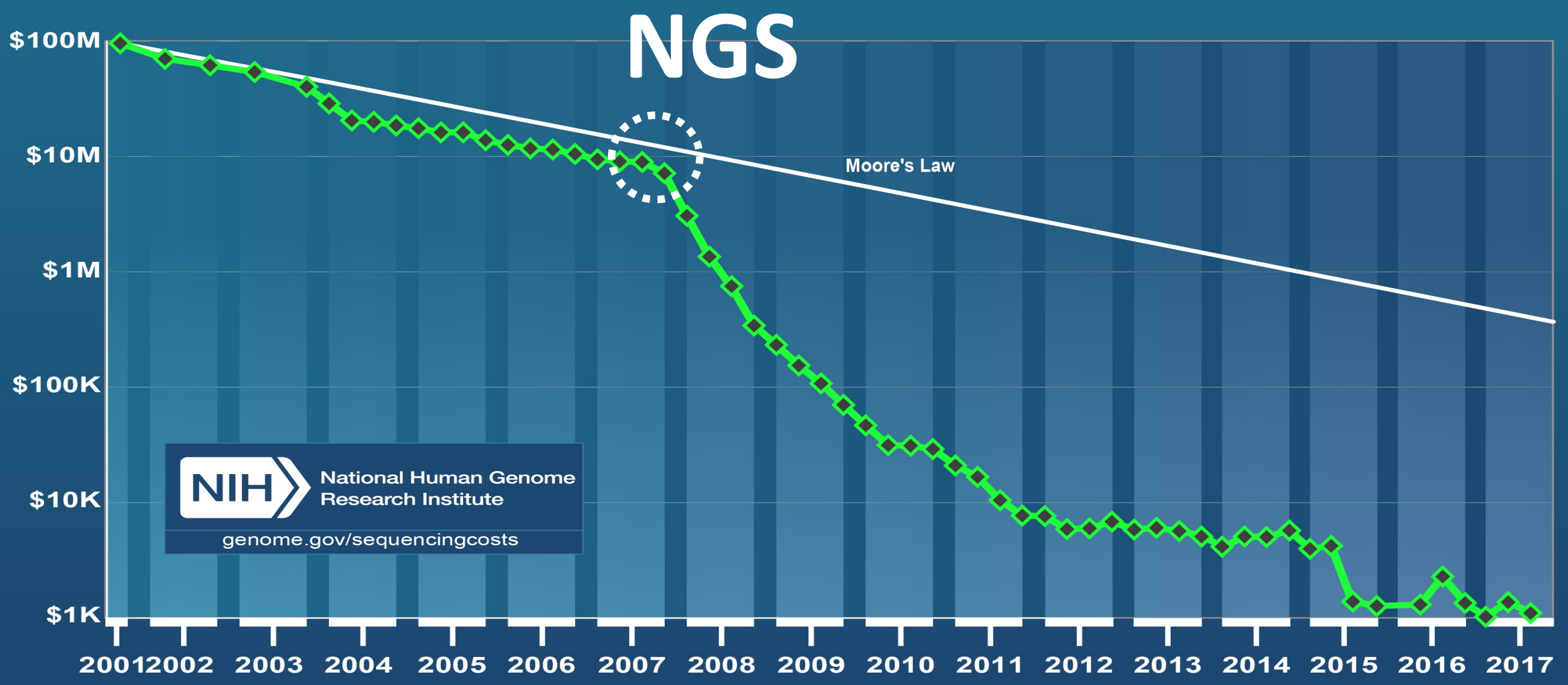
The Digital Universe: 50-fold Growth from the Beginning of 2010 to the End of 2020

(The Digital Universe, EMC/IDC 2014)



WinterCorp Survey: Processing technology grows much slower than data

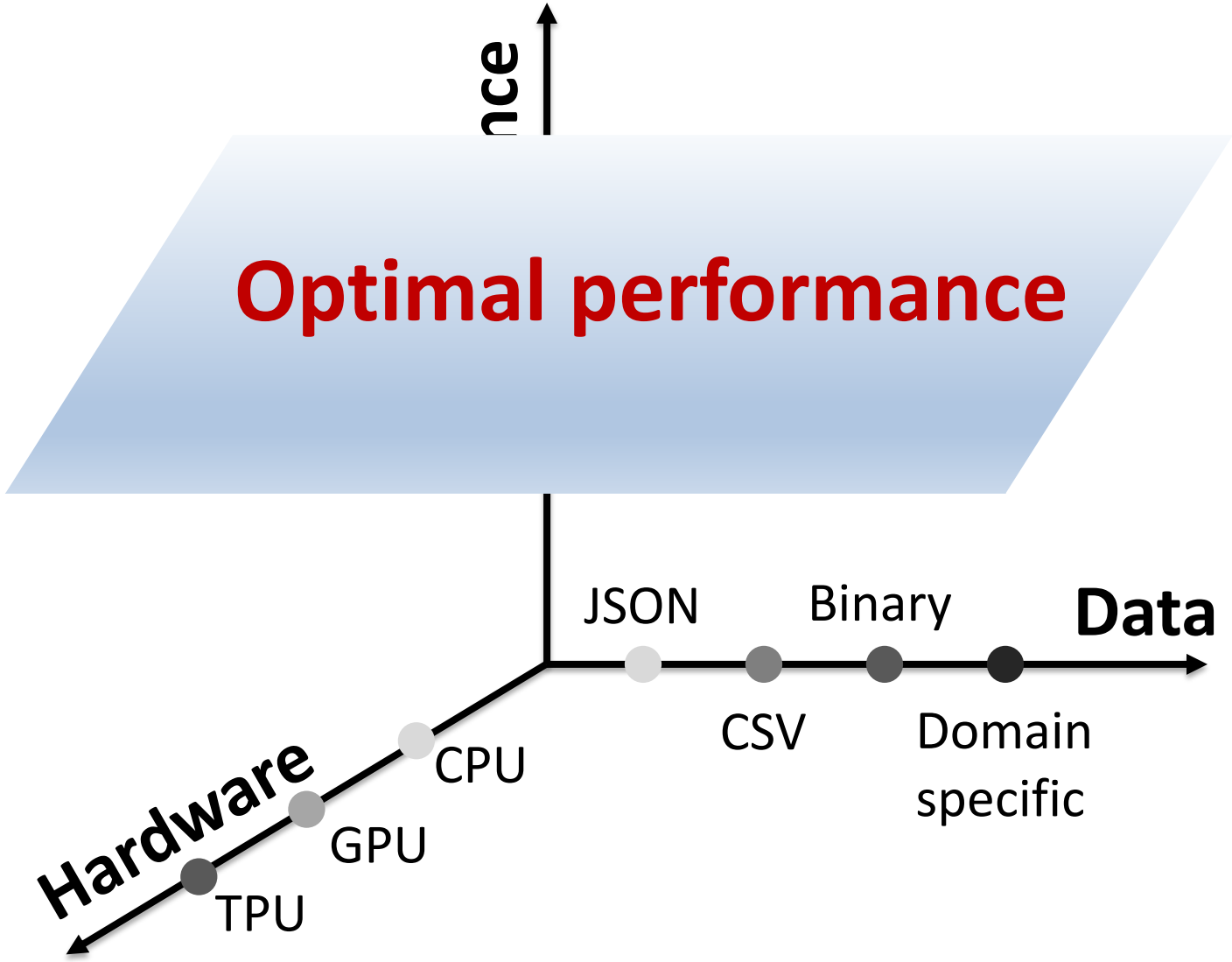
Cost per Genome



Major challenges

- Make the most use of the hardware
- **BUT** only of the hardware needed

Heterogeneity in two dimensions



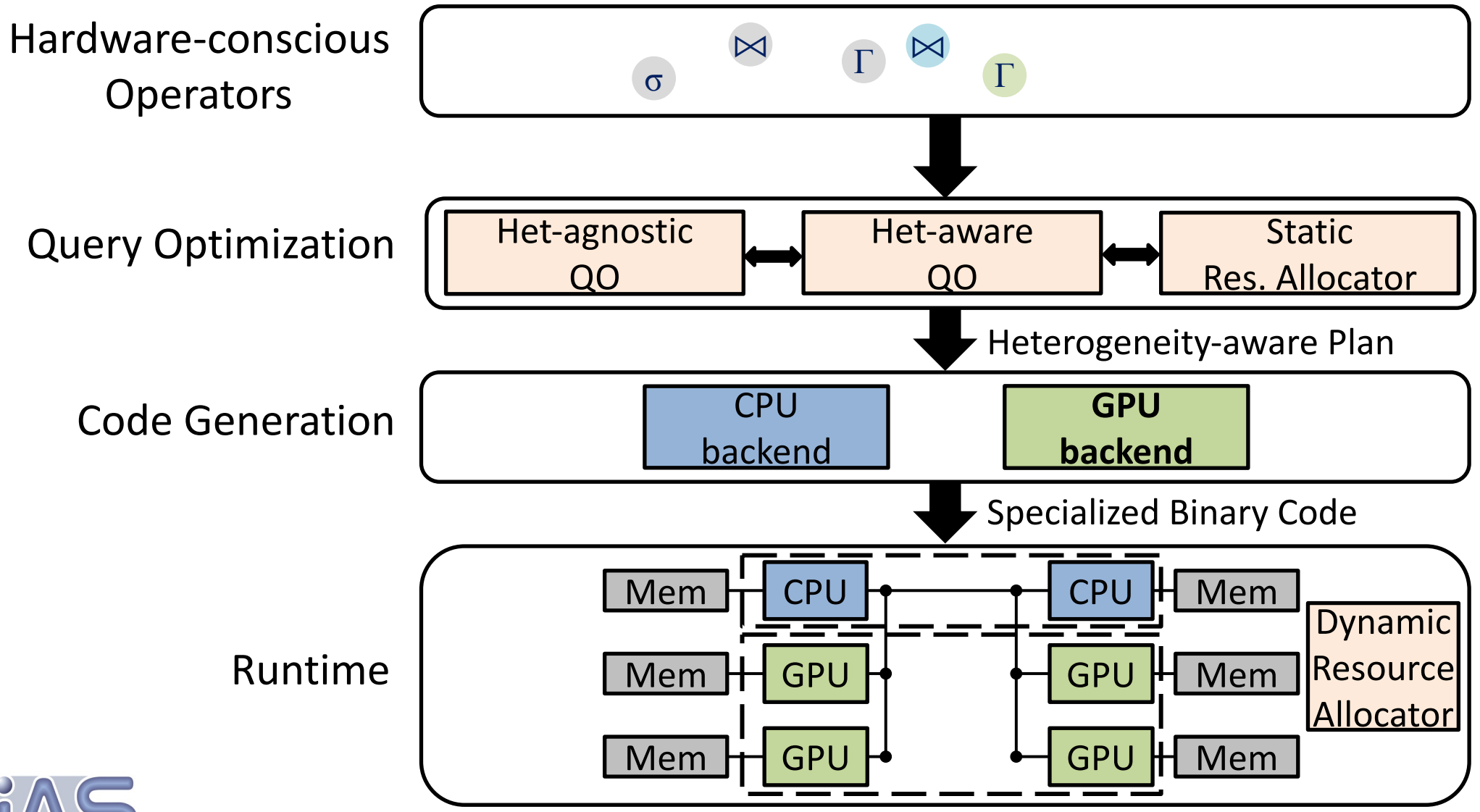
Just-in-time approach

- Optimize query operator execution for
  - Different data formats
  - Different processing devices
- Common abstractions for data
  - Data virtualization
- Common abstractions for query operators
  - Route data across devices

Massively Parallel Processing in a Single Server

- Avoid overheads of shuffling data over the network
- Use the available hardware of a single server
  - Multi-socket multi-cores with 100's – 1000's of CPU cores
  - GPUs as hardware accelerators
  - Expecting more in the future
- Need to move data around devices of a server

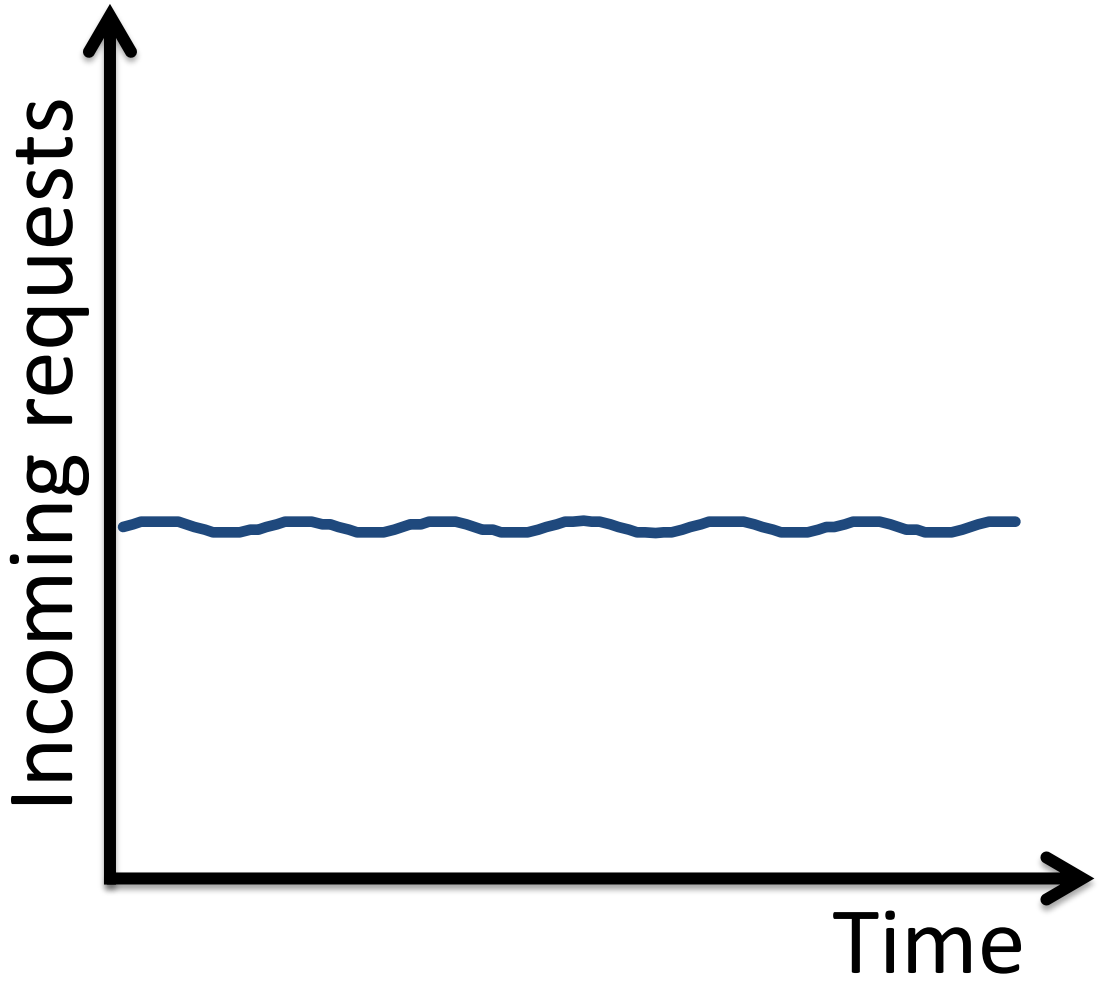
Proteus architecture

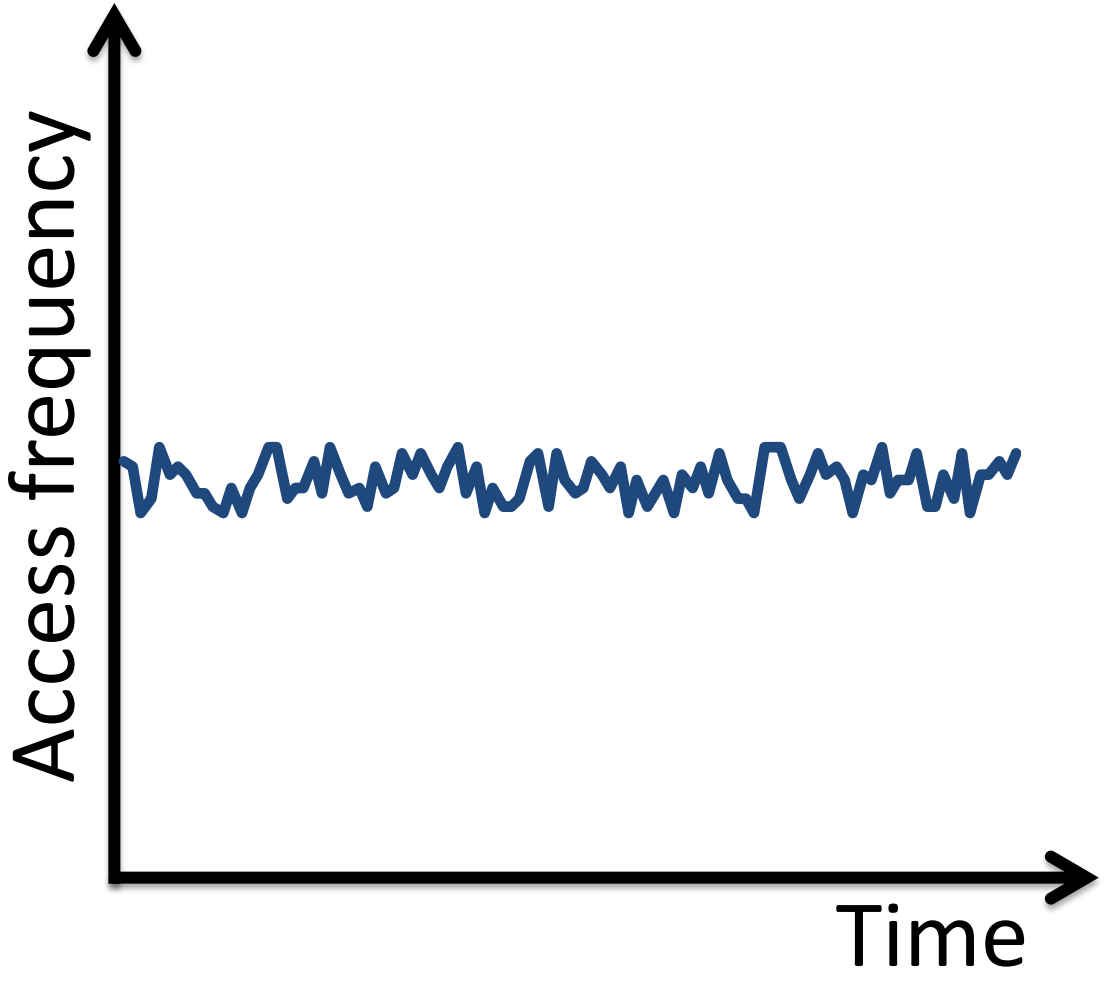


Major challenges

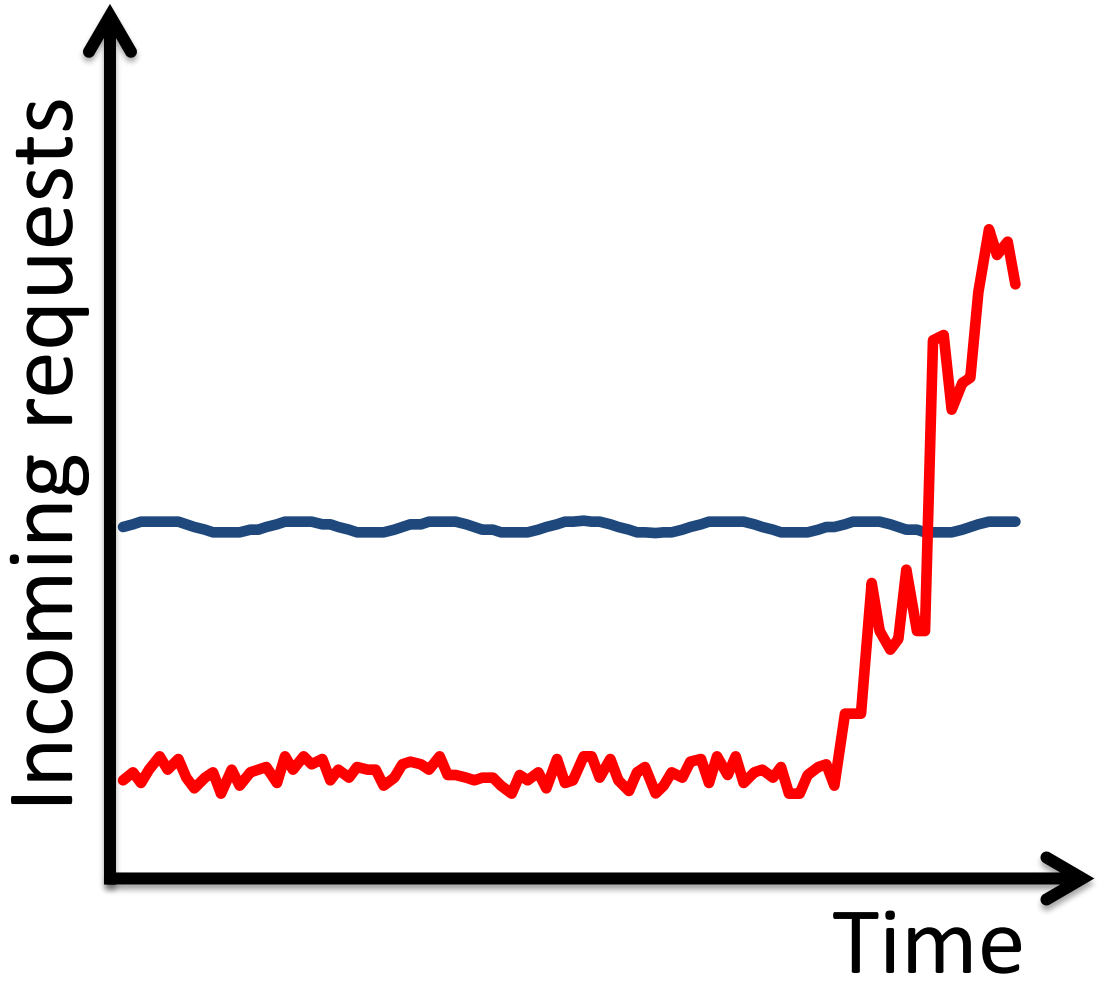
- ~~Make the most use of the hardware~~
- **BUT** only of the hardware needed

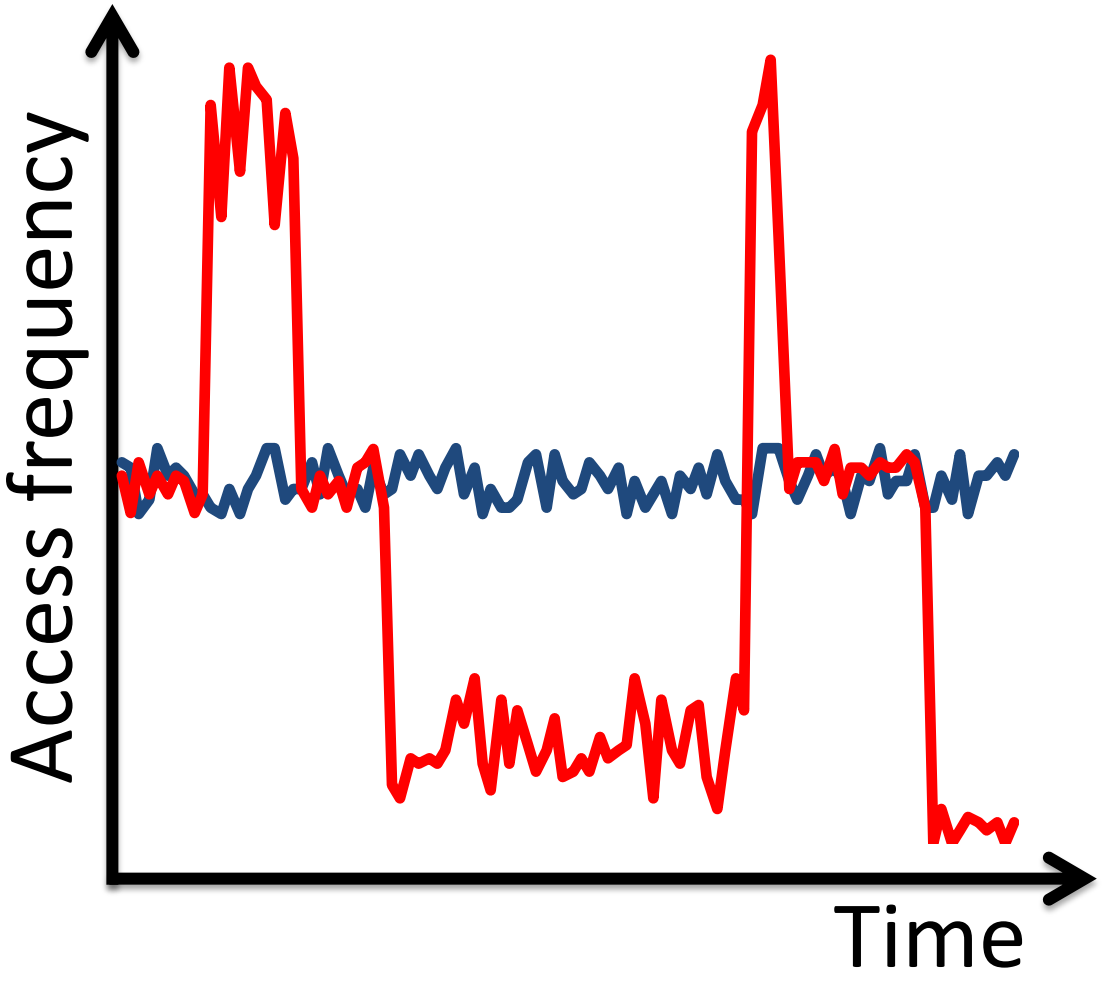
DBMS workload – Ideal situation





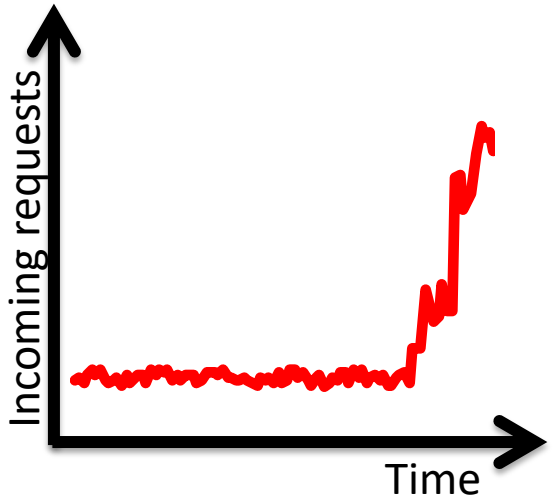
DBMS workload – Reality

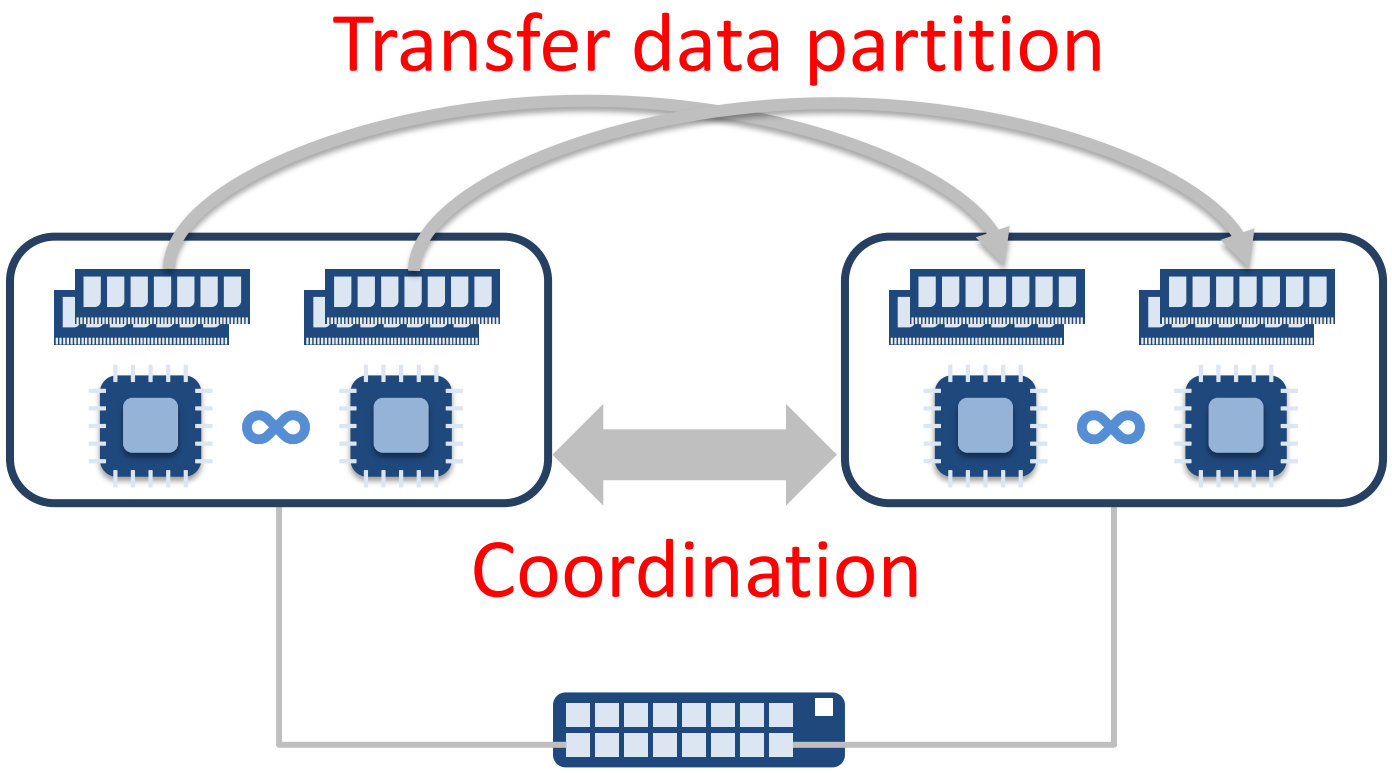




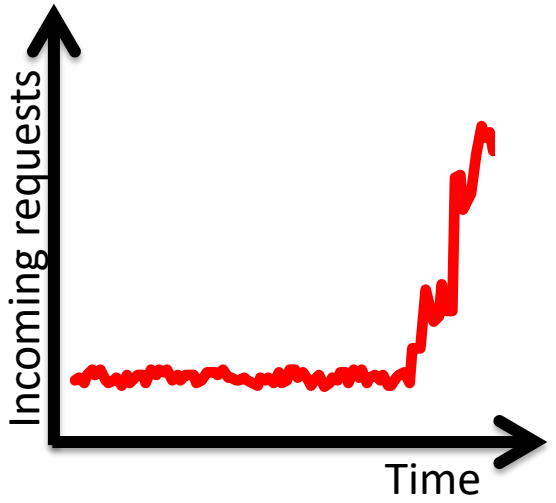
Adapt resource allocation to workload variations

Elastic scale-out DBMS

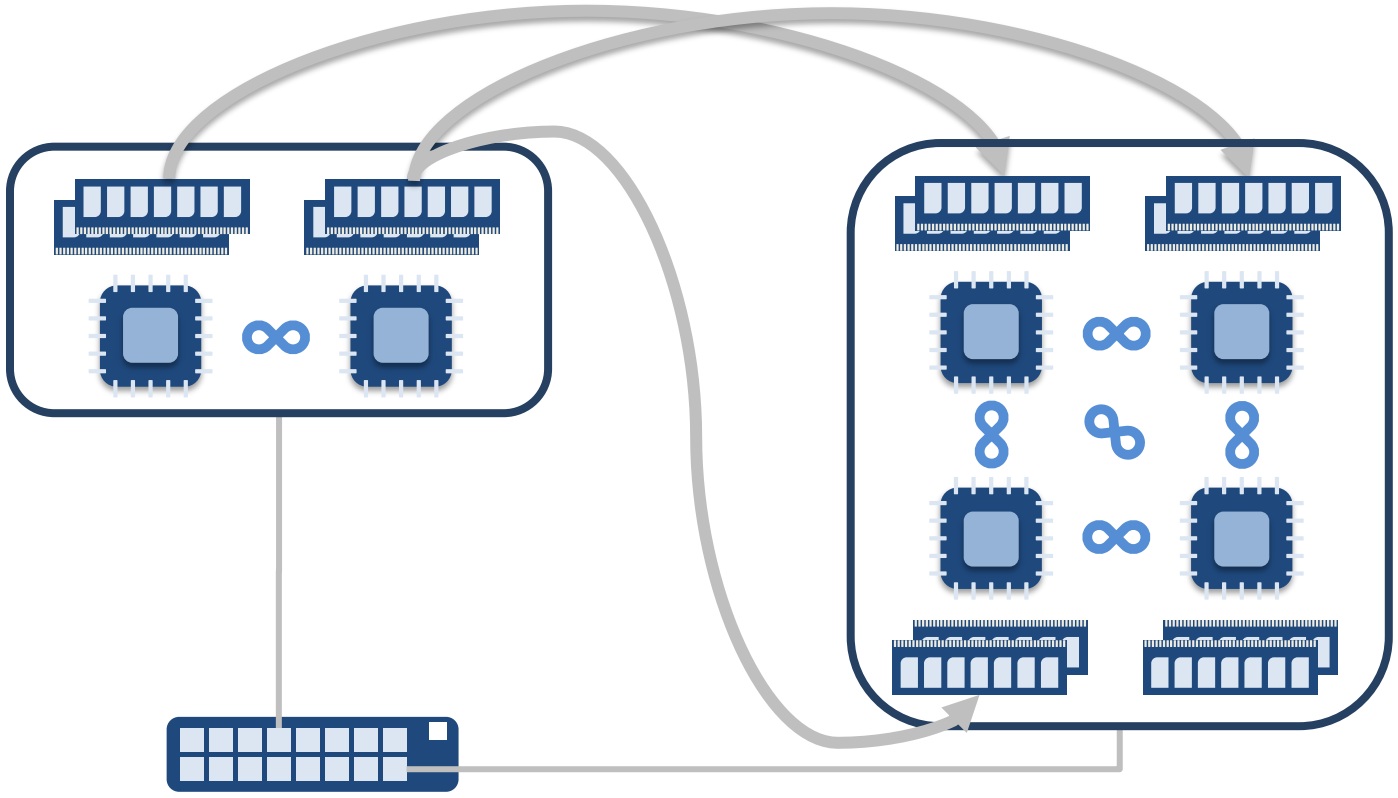




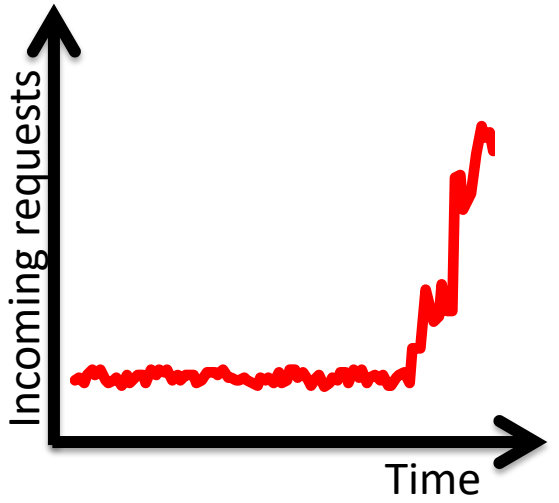
Elastic scale-out DBMS

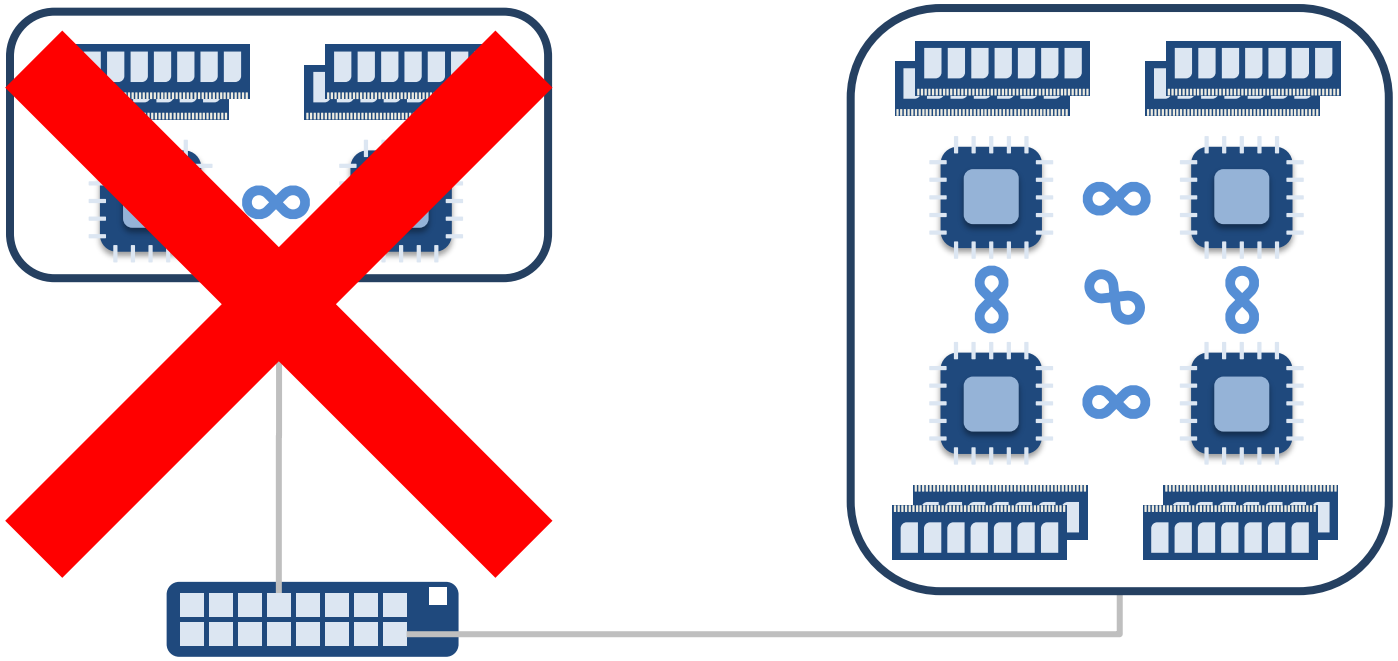


Transfer all data



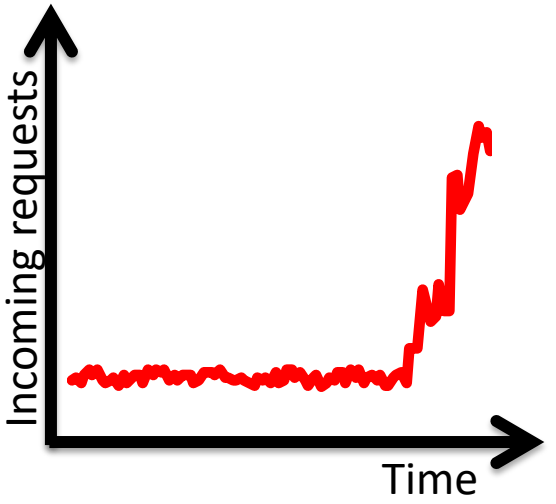
Elastic scale-out DBMS

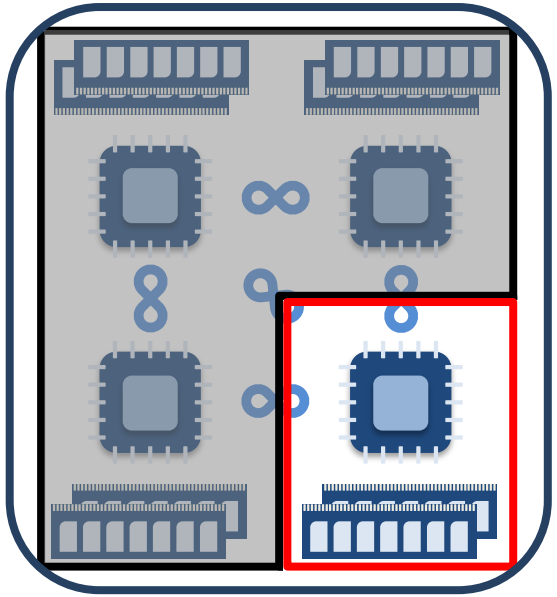




Pay only once for data transfer

Elastic scale-out DBMS

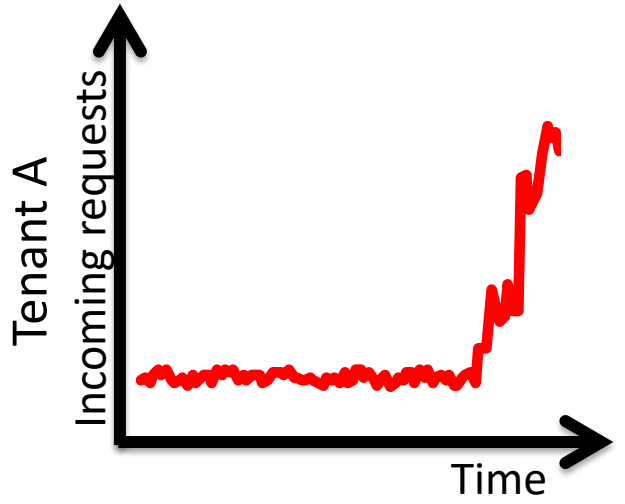


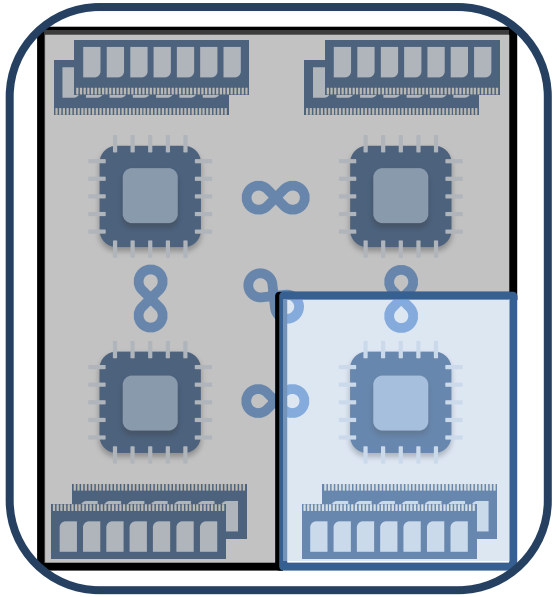


Idle

Coarse-grained → resources underutilization

Elastic scale-up DBMS





Tenant A

Tenant B

Elasticity at hardware thread-level granularity

Elasticity – To scale up or to scale out?

- Scale-out can grow up to the cluster/data center size
  - Copy data across nodes over the network
  - Data shuffling and hard coordination

Long-term decision

- Scale-up can only grow up to the server size
  - No need to copy data – at most it will be across NUMA nodes
  - Standard coordination

Short-term decision

Scale-up elasticity benefits

- CPU/memory hotplug with minimal cost
  - Application interrupt time = 1 context switch
- Enable spot-instance model for stateful applications
- Beneficial for short-lived workload variations

European Research Council

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