

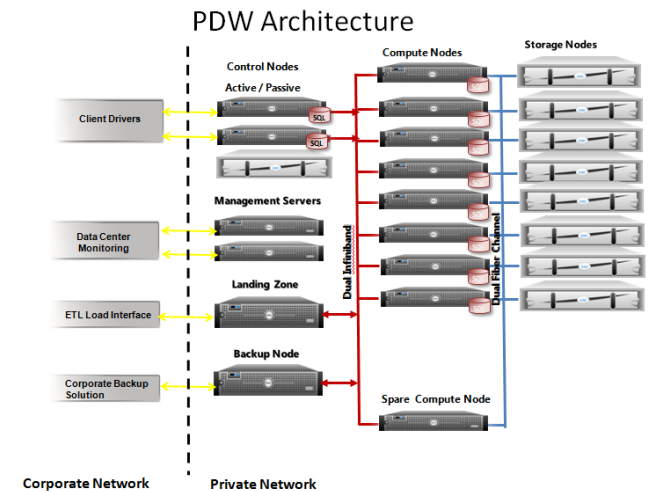
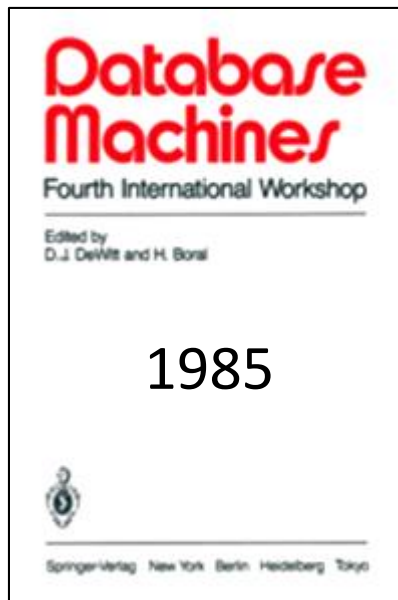
Accelerators for Machine Learning of **Big Data**

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The “new” slogans

- Send the query to the data
 - Process near memory
 - Process in memory
 - Processor in the disk
-
- So far, they mostly apply to small data

Processing near disks: Database Machines



Processing near memory: In-memory database → analytics



Goodyear MPP
1983

Maintain all the data efficiently in memory ...



Worlds largest SAP HANA system



100 tb

Powered by

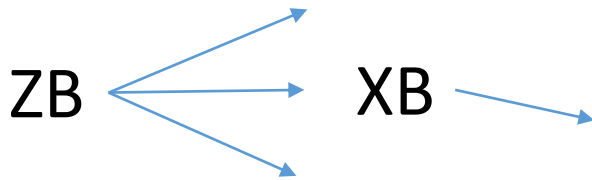
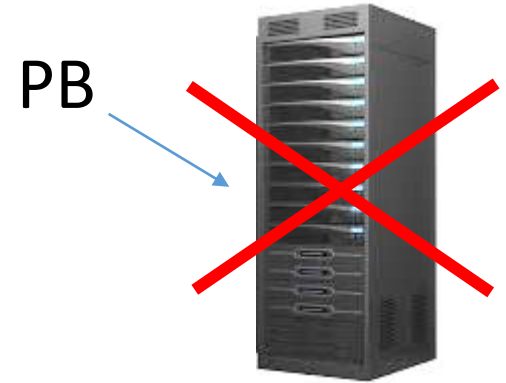


BIG DATA is not small data

- Accelerators for big data are not accelerators for small data
- The challenges are different
- Small data: performance, power
- Big data: energy

What is big data?

- Doesn't fit on a server
- At least an entire data center
 - Or many centers



- Example: global med/healthcare data
 - 10B persons, 10TB/person (omics, records, streams) = 100ZB

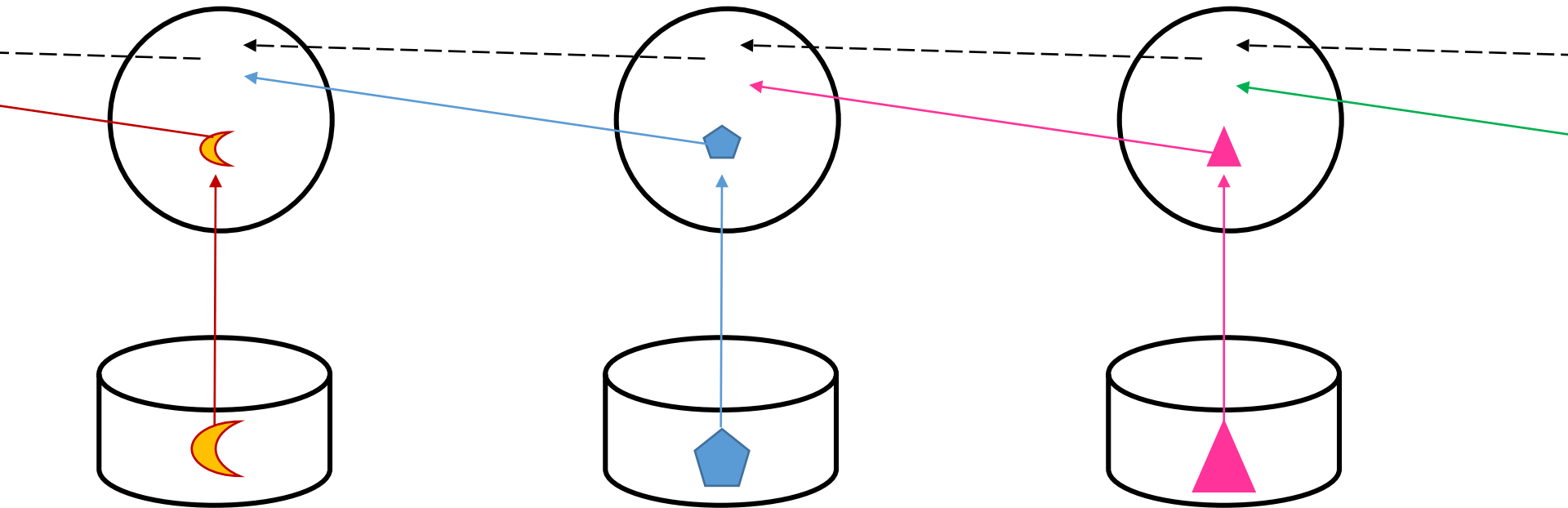
What is machine learning for big data?

- Entire data is needed
- Entire data is cross-associated
 - Multi-variance questions:
 - What features predict a specific disease at > 99%?
- N records, K features: $O(N^K)$
 - Imagine N=100 million persons, K=10 million features...
 - Interim algorithms hope for $O(N^m)$, m small integer
- Compute energy is easy
- Moving BIG DATA to BIG DATA is **BIG ENERGY**

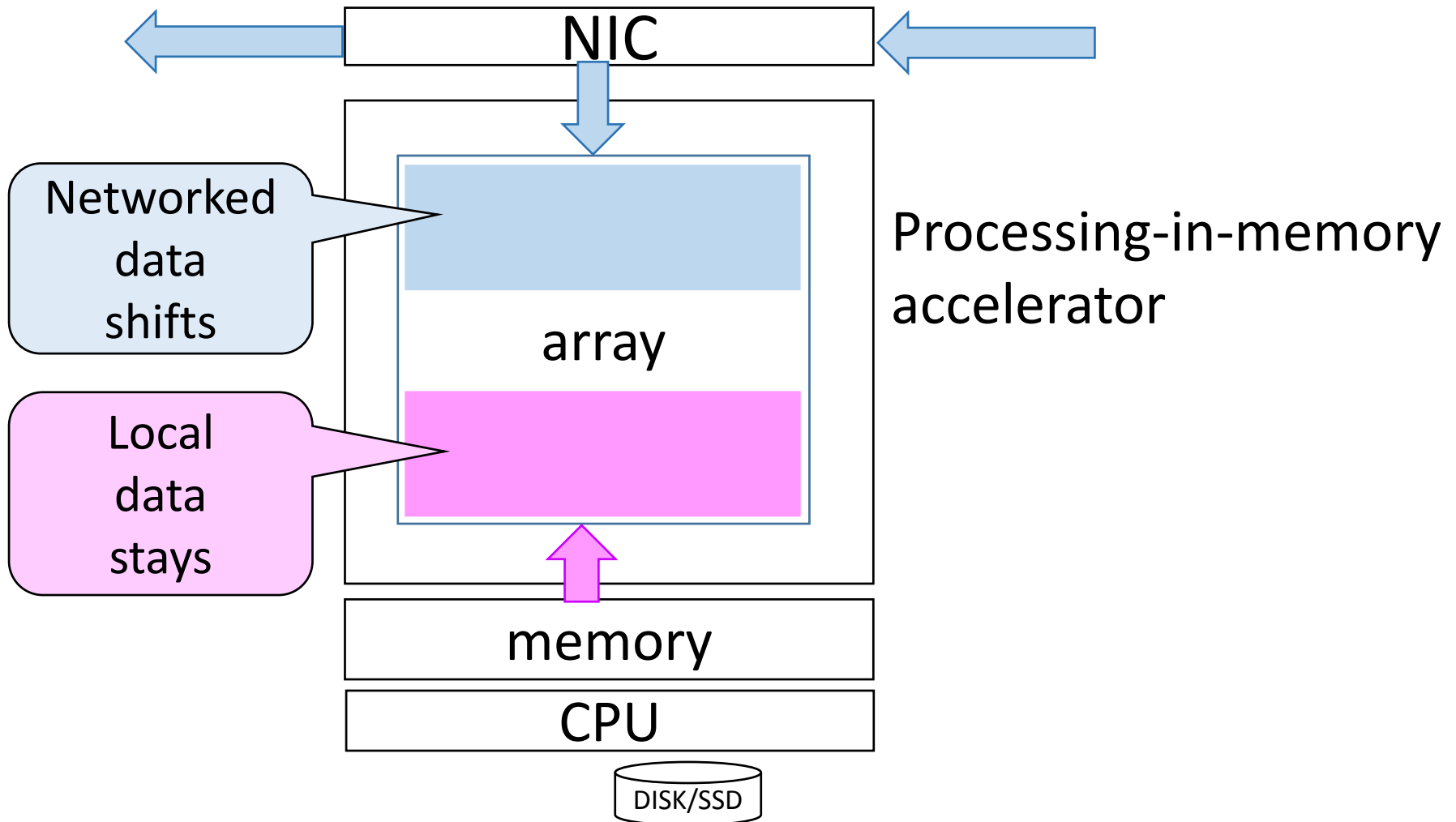
Energy

- Compute:
 - One SPFP: 20 pJoule
 - ExaFLOP: 20 M-Joule
 - Take 0.2 sec on 100 MWatt data center
- Move the data only once within a data center:
 - One bit, Chip-to-chip: 50 pJoule
 - One ExaByte, within one data center: 50 Tera-Joule
 - Take **6 days** on 100 MWatt data center

The BDML data center

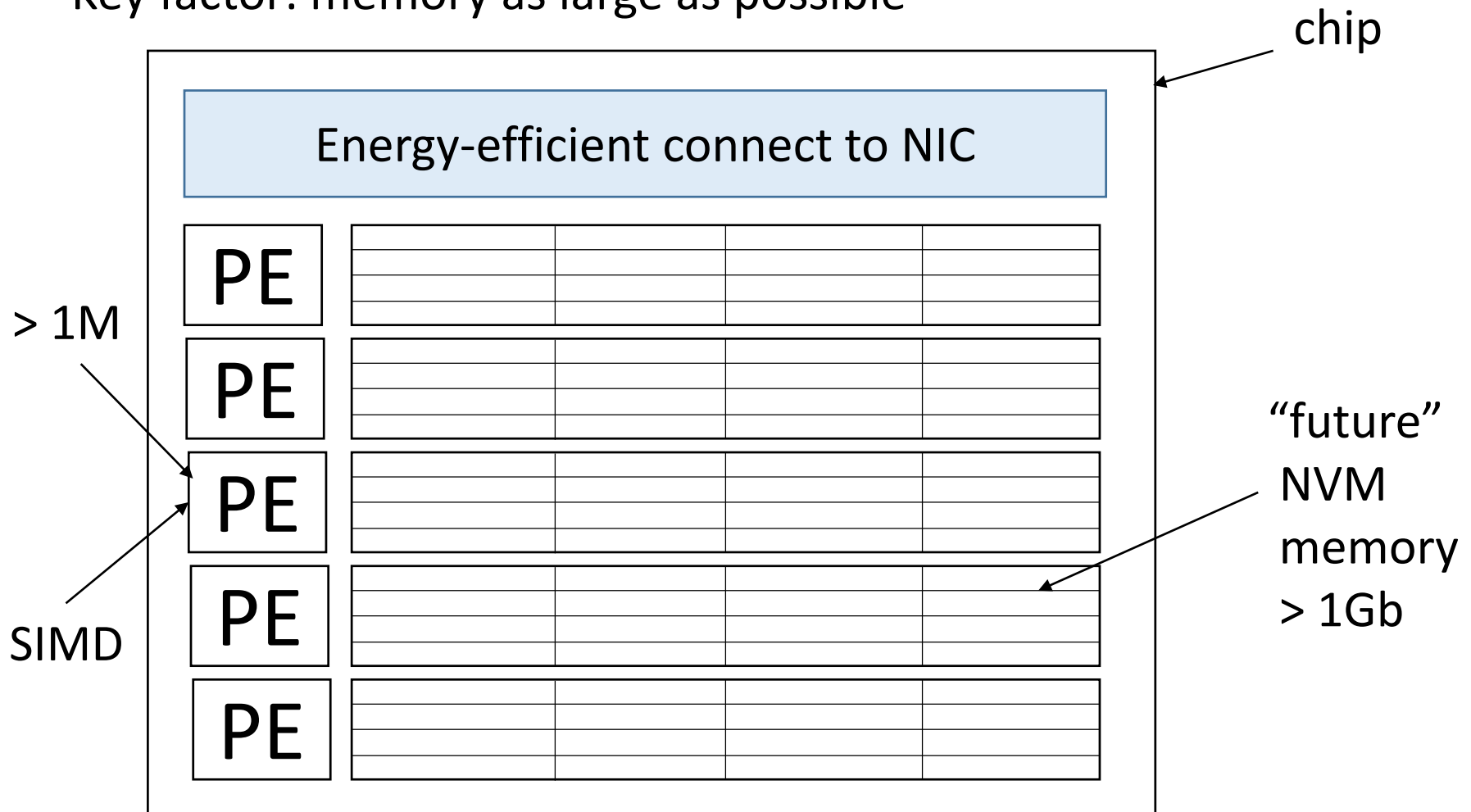


The BDML server node

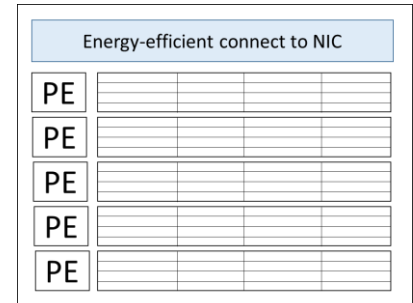


The BDML accelerator

Key factor: memory as large as possible



The BDML accelerator



- Studied memristor-based architecture with 100Mb
 - Goal is 10 Gb. Need 3D integration
- Simulated sparse matrix-matrix multiplication
- Showed 10 GFLOPS/watt
 - CPU, GPU are less than 1 GFLOPS/watt
 - Goal is 1 TFLOPS/watt

Summary

- Rather than bring the accelerator close to memory, accelerator IS the memory
- Lots of distant data must be brought to it, to be compared with local data.
Should minimize energy for data moves
- Accelerators with larger memory help minimize overall energy of BDML