

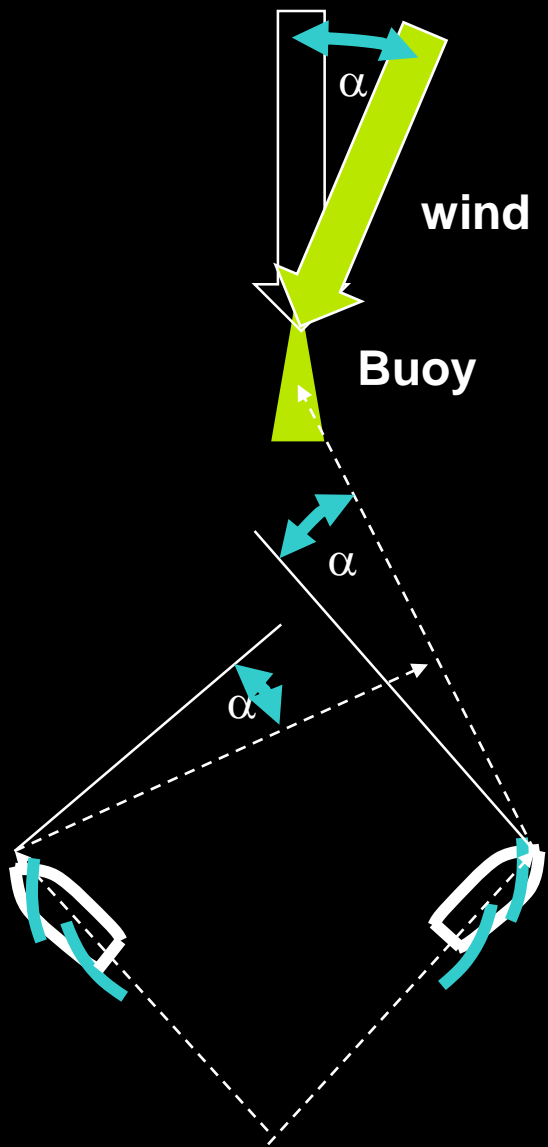
Assignment by Yale

- **“Your vision of the future of computer architecture. From the man who gave us MMX, refused to kill the golden goose, and worked for a time in the same box with Mark McDermott”**

Situation

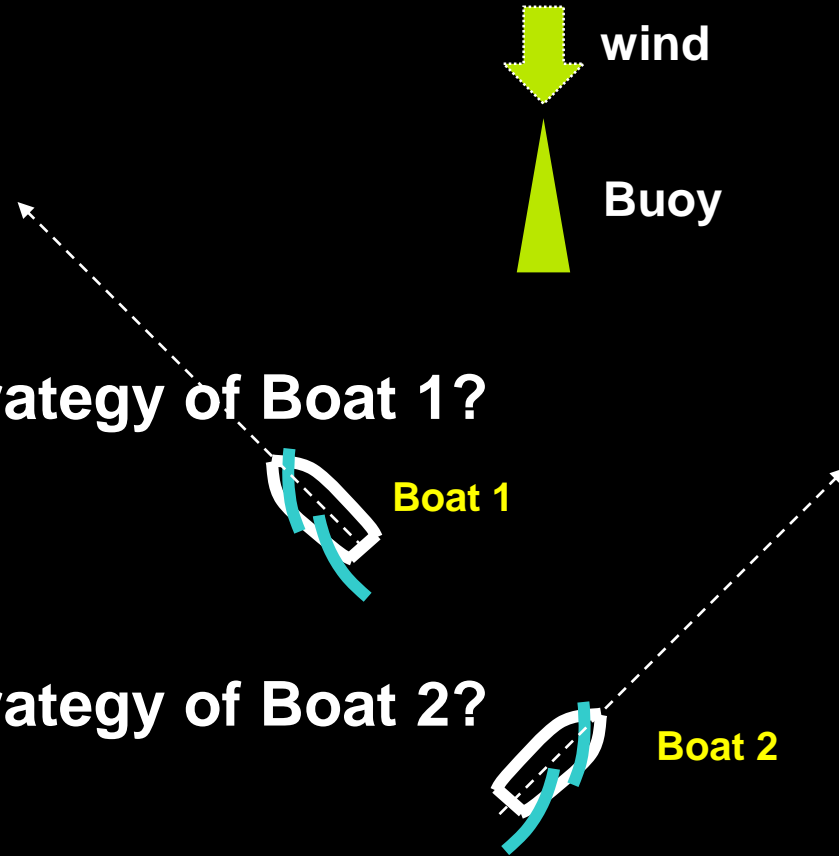
- Flew 11,482 km to greet Yale 😊
- Have to fight again with Bob
- What can I fill-in after this extraordinary speaker?
- Defiantly a challenge

My moto: Sailing - wind shift



Sailing competition

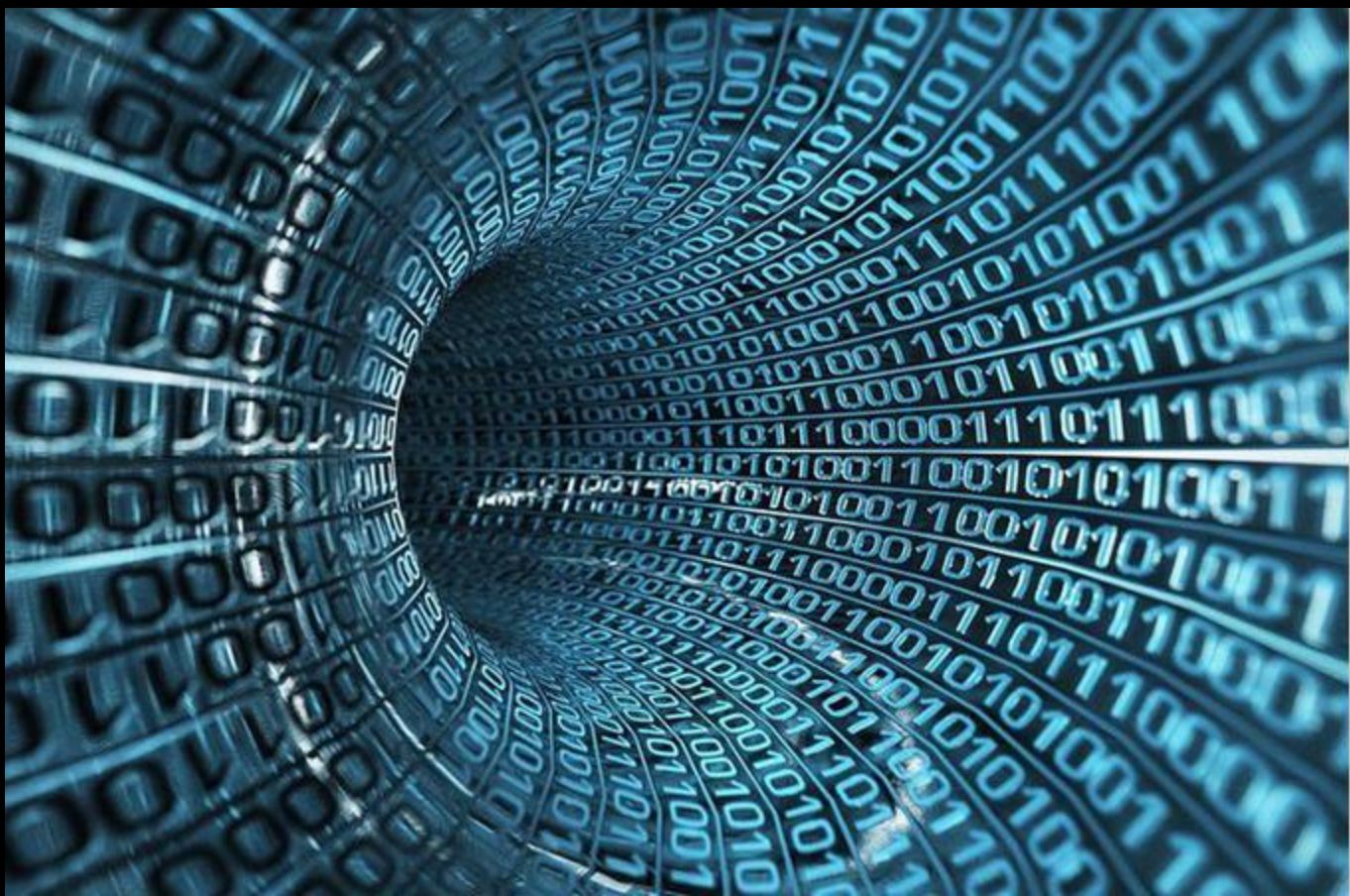
getting first



- What is the Strategy of Boat 1?

- What is the Strategy of Boat 2?

My Moto: Do not follow → Invent



Future Architecture Research Big Data environment

Outline

- **Big Data need → reduction in energy/task**
- **Power/Energy - the opportunities**
 - **Heterogeneous systems – past thoughts**
 - **Resource allocation in a Heterogeneous system**
 - **Efficient computation → reduction of Data movements**
 - **Avoid-the-Valley – past thoughts, deferent perspective**
 - **Big Data execution – where should we preform execution of “Funnel” functions**

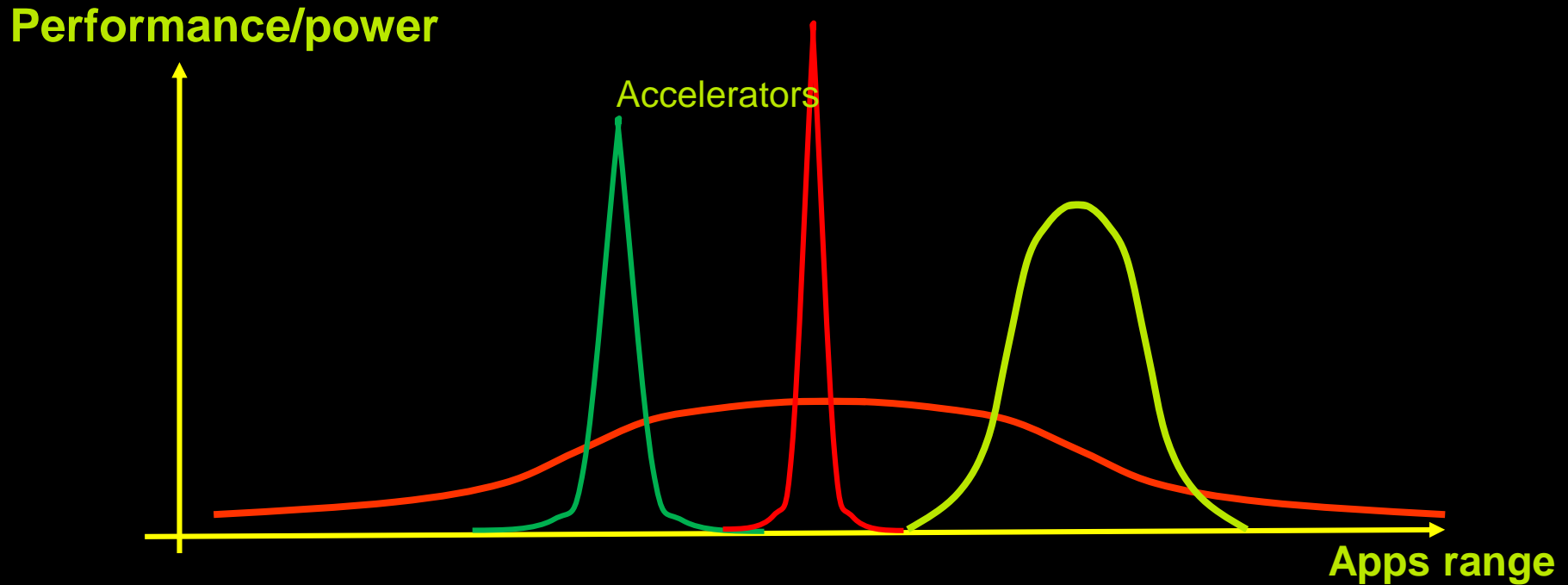
Big Data → reduction in energy/task

- Hadoop/Spark Calls for multiple computing engines taking care of “ONE TASK”
- Computing Centers’ attention was shifted from Performance toward energy saving
- The need for huge amount of processing → huge consumption of energy
- See Google centers...

Power/Energy the opportunities

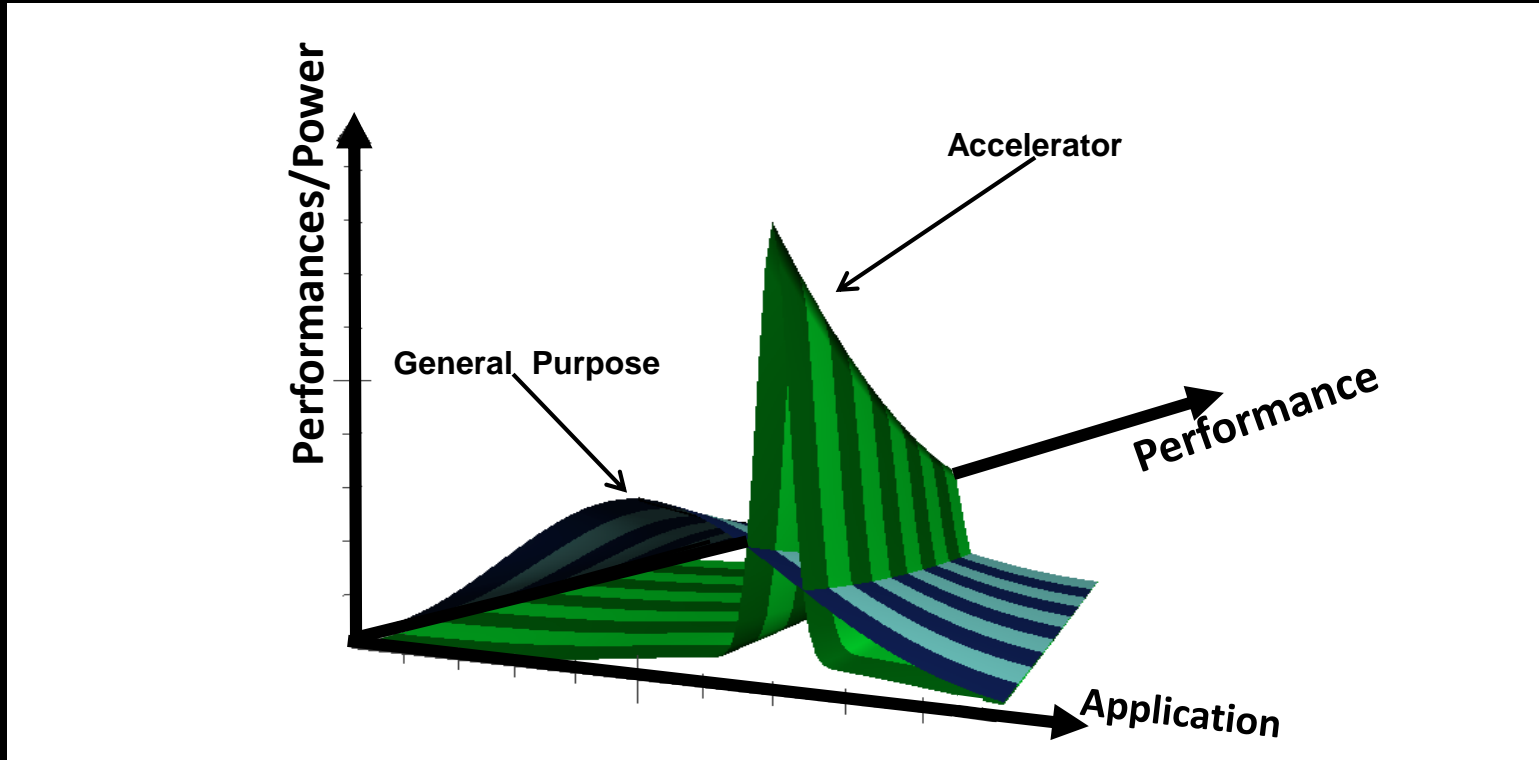
- **Heterogeneous Systems –Past findings**
 - Resource allocation in a Heterogeneous system - MA
- **Efficient computation → reduction of Data movements**
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Heterogeneous Computing: Application Specific Accelerators

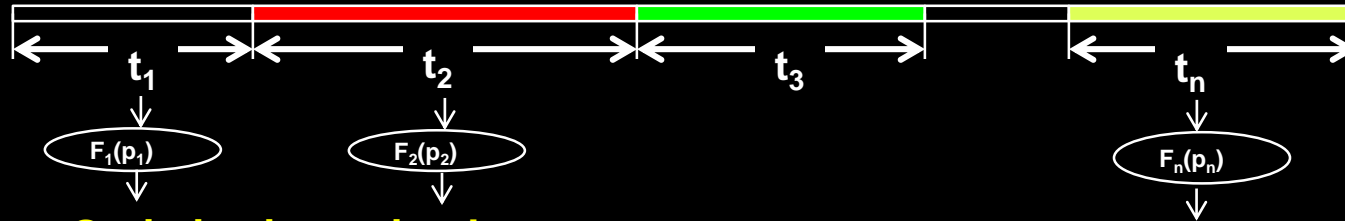


Continue performance trend using Heterogeneous computing to
bypass power and energy hurdles

Heterogeneous Computing



MultiAmdahl:



- **Optimization using Lagrange multipliers**

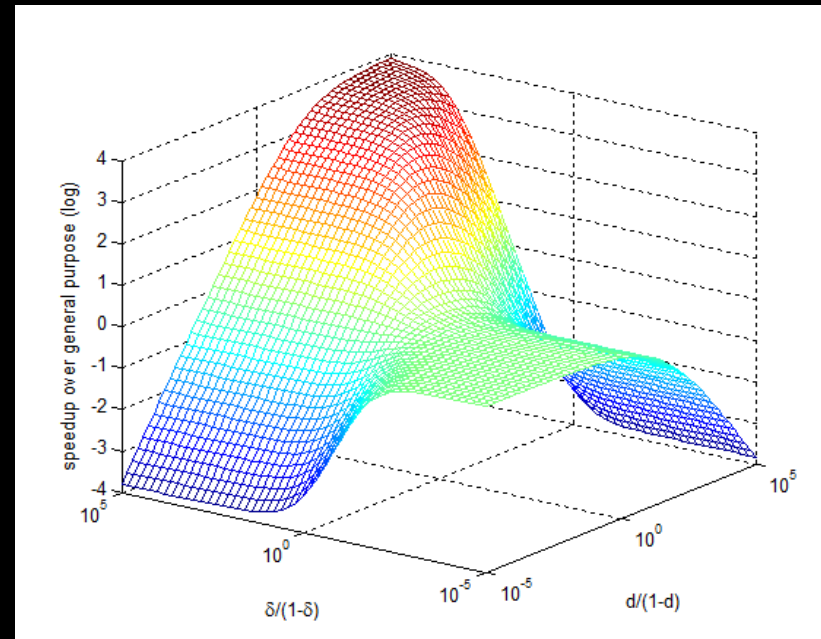
Minimize execution time (T)
under a Area (a) constraint

$$t_j F'_j(p_j) = t_i F'_i(p_i)$$

F' = derivation of the accelerator function

p_i = Power of the i -th accelerator

t_i = Execution time on reference computer



Power/Energy the opportunities

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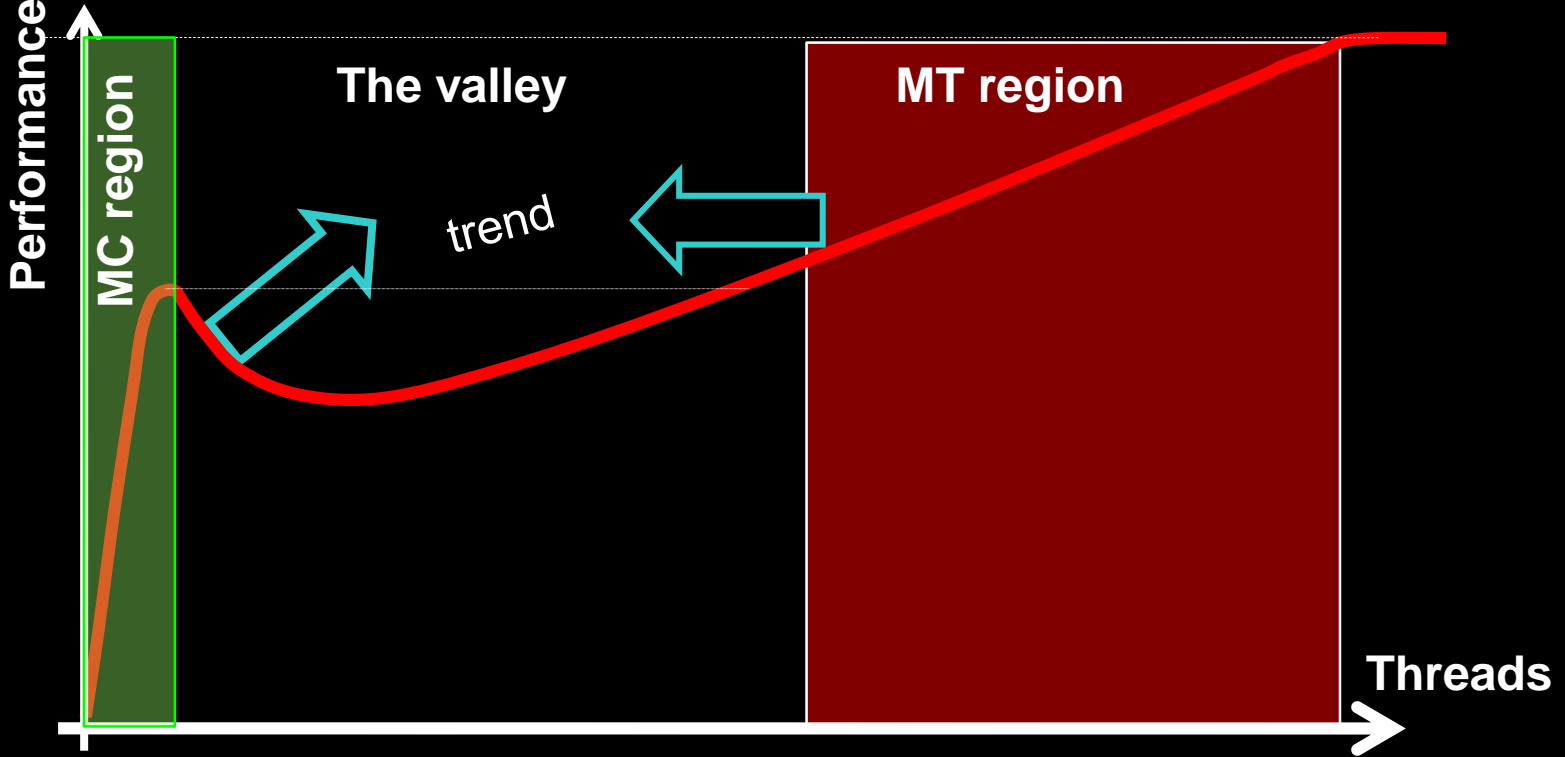
Power/Energy the opportunities

Efficient computation → reduction of Data movements

- **Avoid-the-Valley – past research → power implications**
- **The Funnel PreProcessing (FPP):
ak'a “In-Place-Computing” =
Compute at the most energy effective place**

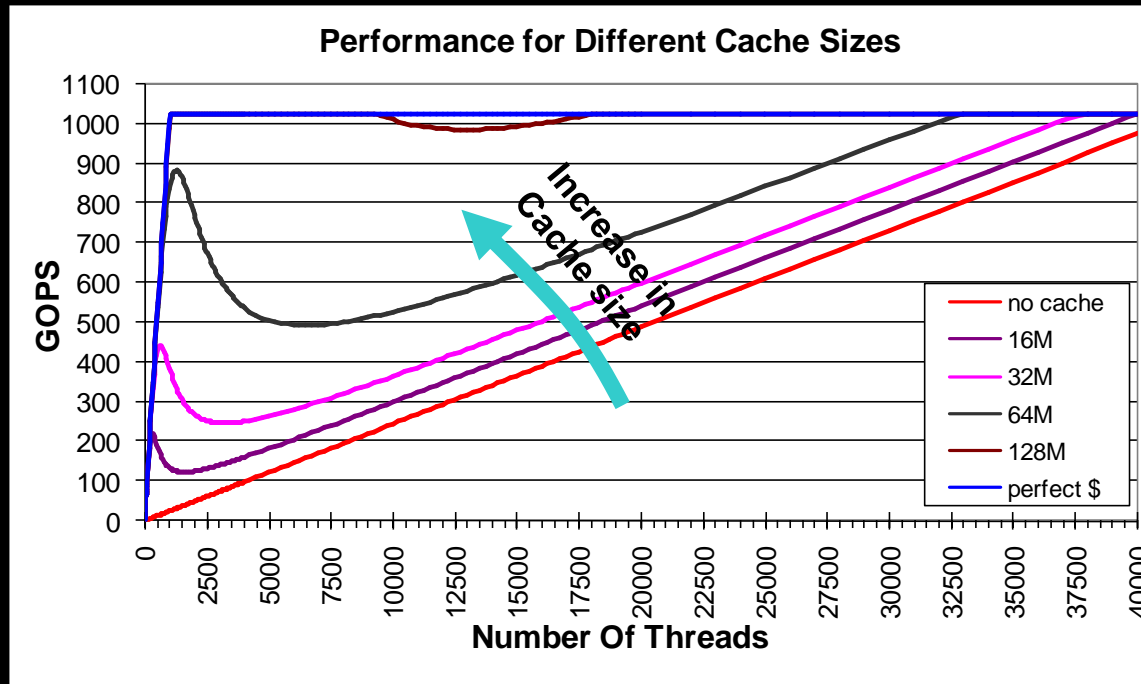
Avoid-the-valley: Many cores behind a common cache running many threads

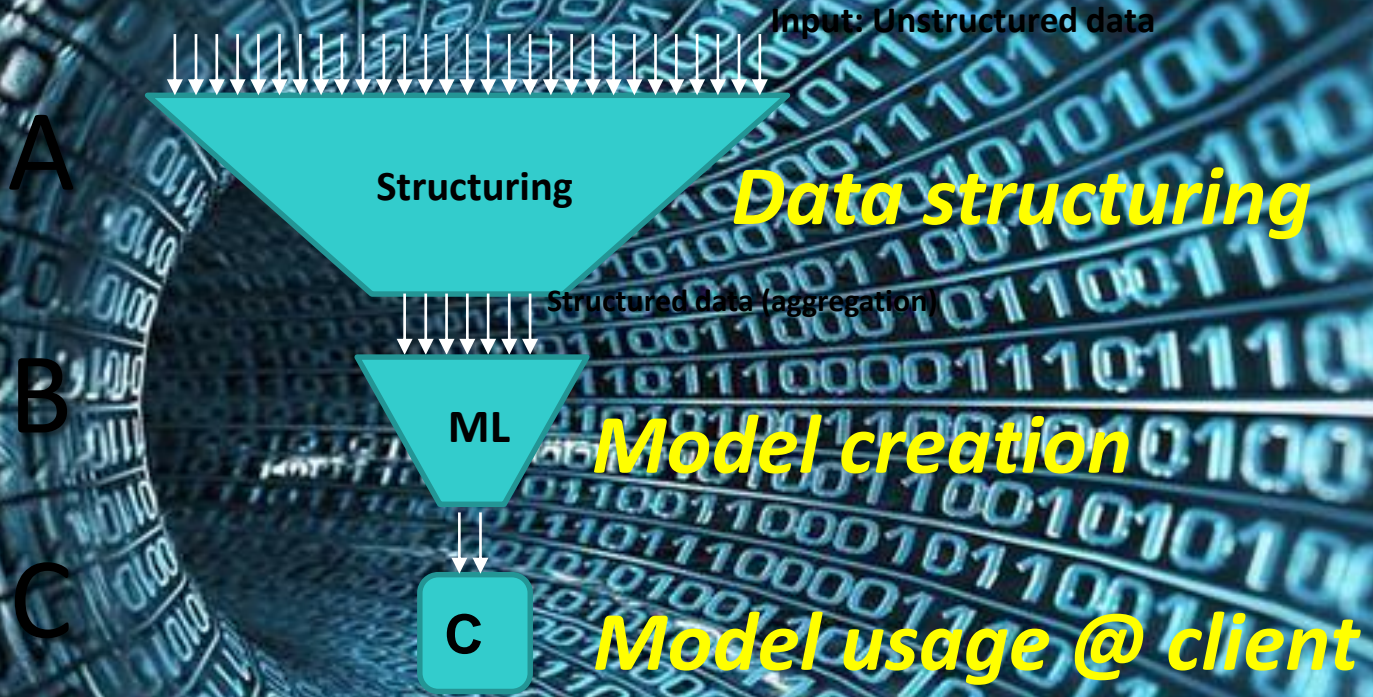
■ Three regions: *MC Region*, the valley, *MT Region*



Avoid the Valley

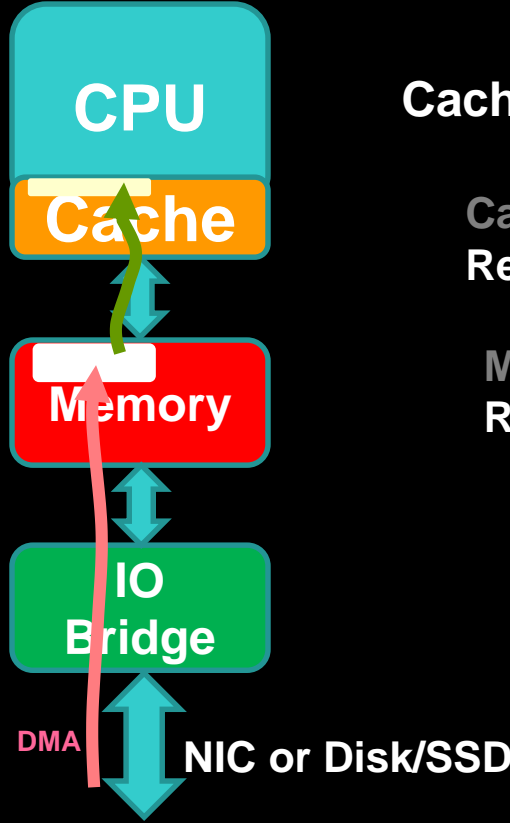
Parameter: Cache Size





Existing Big data: Data movements

Copy of data 
~nJoules/Byte



Cache/Memory are not effective if:

Cache related:
Reuse distance: >1M access

Memory related:
Reuse distance: >1G access

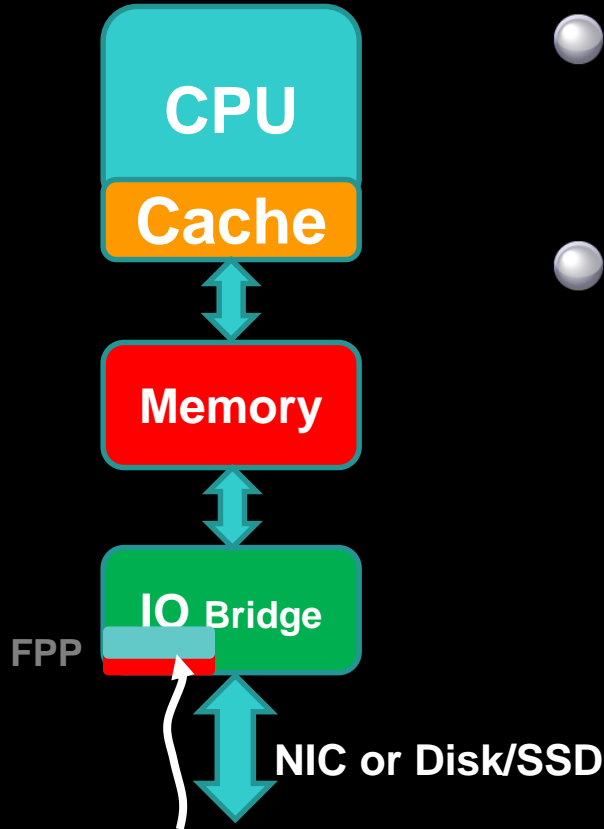
1. Why used-once data should move all the way to the “BIG” CPU?
2. Why use-once data is copied to memory?

Initial analysis: Hadoop-grep memory access

- **Analysis of memory Hadoop-grep memory accesses was performed**
- **Unique addresses have been identified**
- **In each pack (10M memory accesses), we counted;**
 - **number of unique addresses that have been single accessed**
 - **number of unique addresses that have been accessed multiple times**
- **About 50% of Hadoop-grep memory references have been single access**

Big Data

Suggestion: Data movements reduction and free-up resources



- **Process Read-Once data close-to-IO**
(Funnel PreProcessing FPP)
- **Implications:**
 - Free huge amount of memory for useful work (think Hadoop/Spark)
 - Process funnel functions by small efficient engines
 - Save Read/Write DRAM energy
 - Think about Big Data...

Open issues for research

- **SW and OS**
 - Co-Processor or
 - Heterogeneous system
- **Compatibility**
- **Application awareness**
- ...

Summary

- **The Funnel functions – execute close to the data source**
 - Free up system's memory
 - Reduction of Data movement
 - Simple energy efficient engines at the front end
 - Issues
 - Compatibility issue: Apps, OS,
 - Amount of energy saving...
 -

Thank You