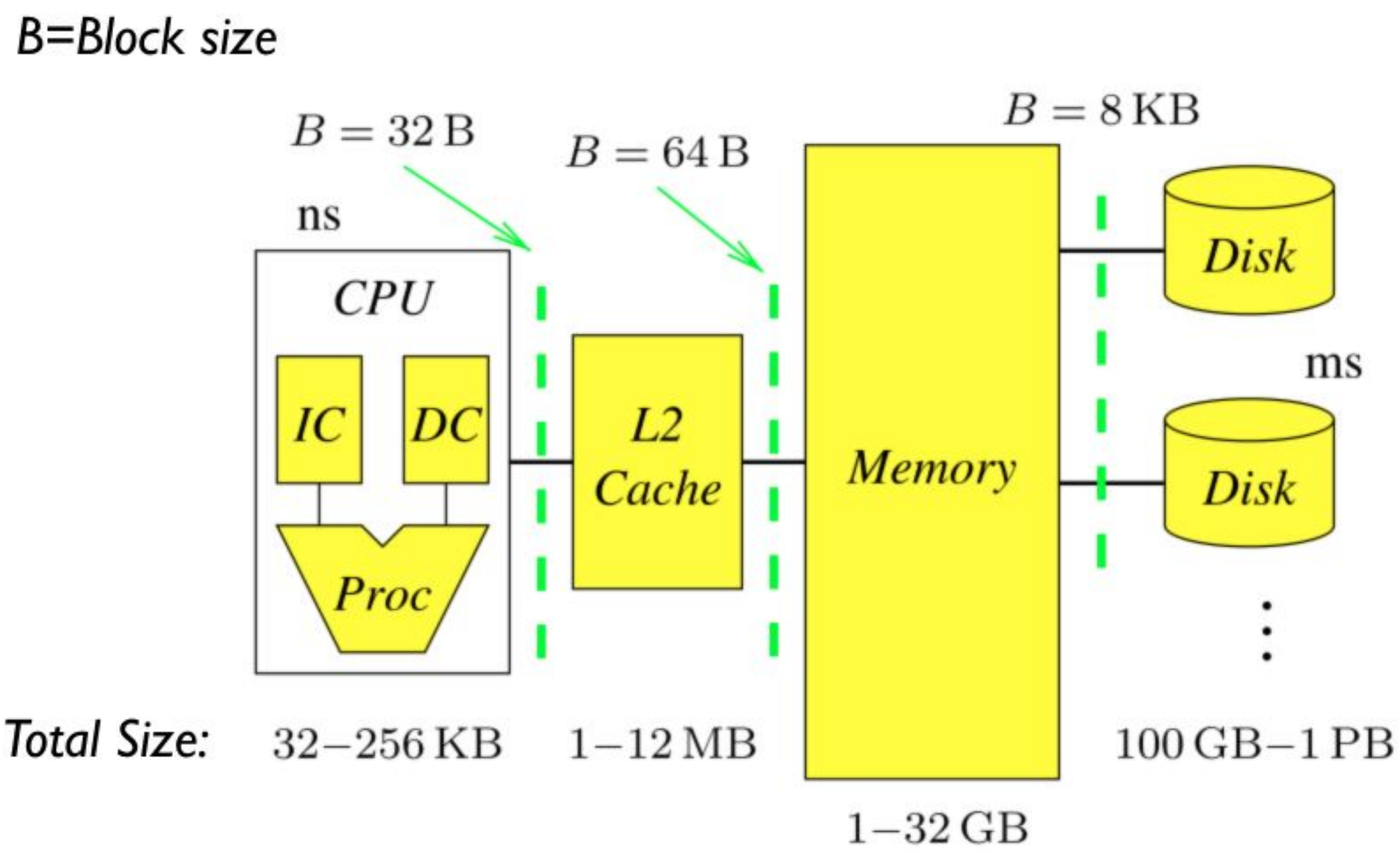
5: The memory Hierarchy

The Memory Hierarchy

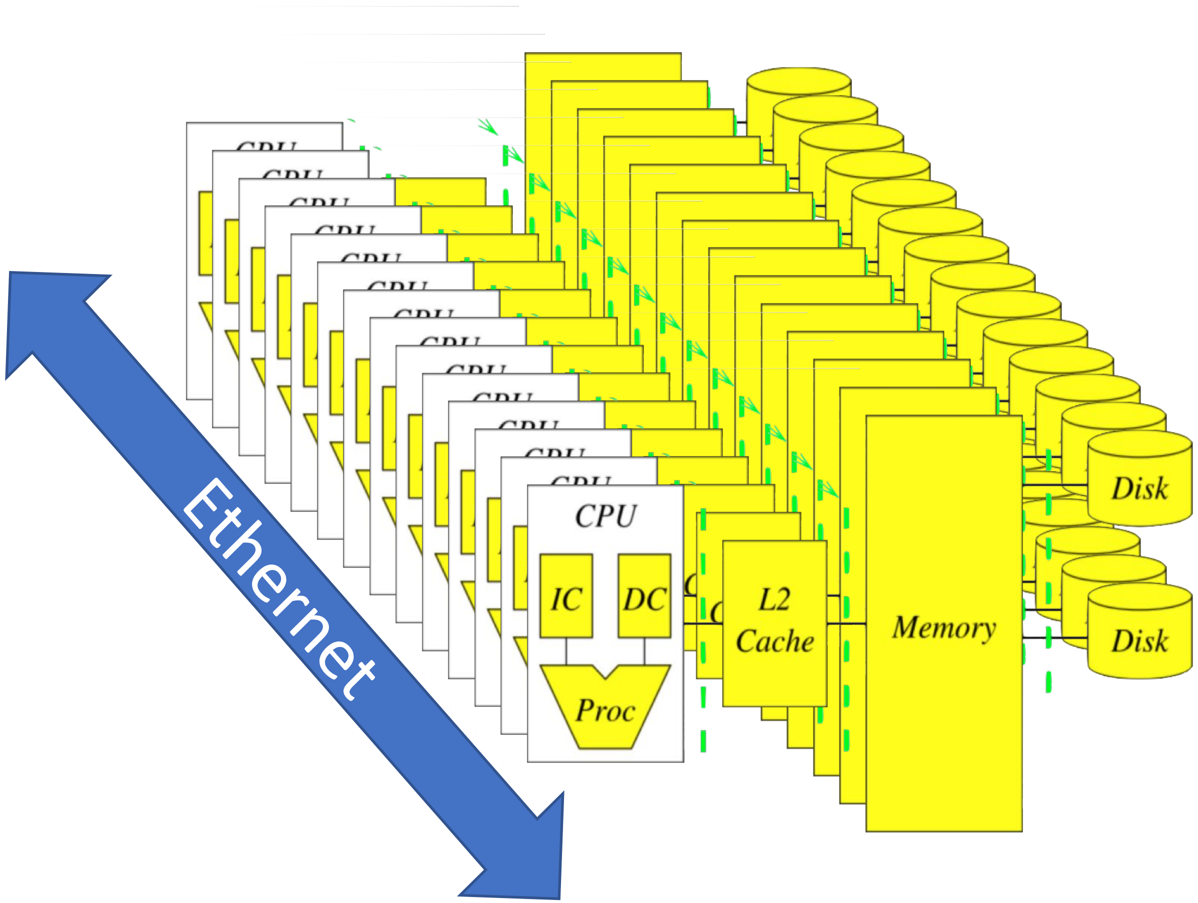
- Real systems have a several levels storage types:
  - Top of hierarchy: Small and fast storage close to CPU
  - Bottom of Hierarchy: Large and slow storage further from CPU
- Caching is used to transfer data between neighboring levels of the hierarchy.
- To the programmer / compiler does not need to know
  - The hardware provides an **abstraction** : memory looks like like a single large array.
- Performance depends on locality of program memory access.

The Memory Hierarchy



Computer clusters extend the memory hierarchy

- A data processing cluster is simply many computers linked through an ethernet connection.
- Storage is shared
- Locality: Data to reside on the computer this will use it.
- “Caching” is replaced by “Shuffling”
- Abstraction is spark RDD.



Sizes and latencies in a typical memory hierarchy.

	CPU (Registers)	L1 Cache	L2 Cache	L3 Cache	Main Memory	Disk Storage	Local Area Network
Size (bytes)	1KB	64KB	256KB	4MB	4-16GB	4-16TB	16TB - 10PB
Latency	300ps	1ns	5ns	20ns	100ns	2-10ms	2-10m
Block size	64B	64B	64B	64B	32KB	64KB	1.5-64KB

12 orders of magnitude

6 orders of magnitude

Summary of part 5

- Memory Hierarchy: combining storage banks with different latencies.
- Clusters: multiple computers, connected by ethernet, that share their storage.