Database Hardware Selection Guidelines

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Database servers have hardware requirements different from other infrastructure software, specifically unique demands on I/O and memory. This presentation covers these differences and various I/O options and their benefits.

 http://momjian.us/presentations

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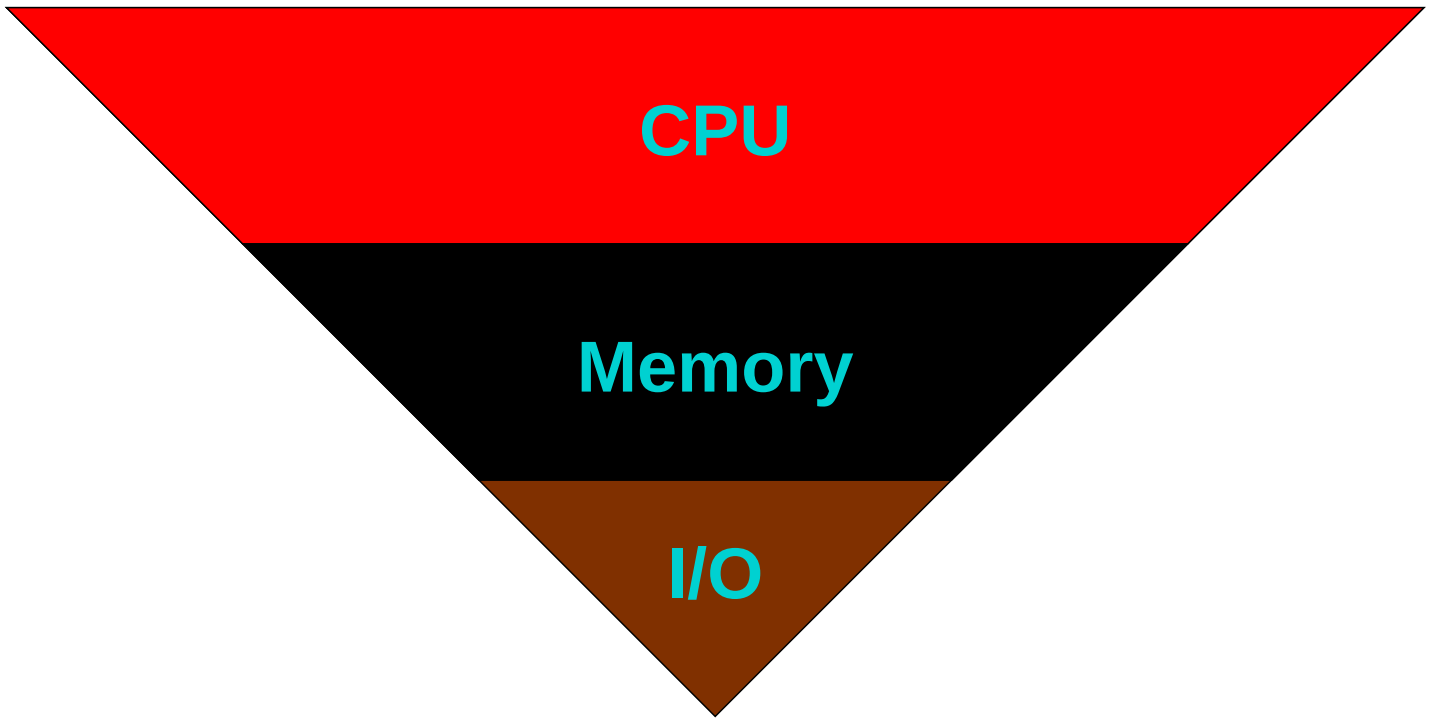
Outline

- CPU
- Multi-threading
- GHz
- Pipelining
- SMP
- NUMA

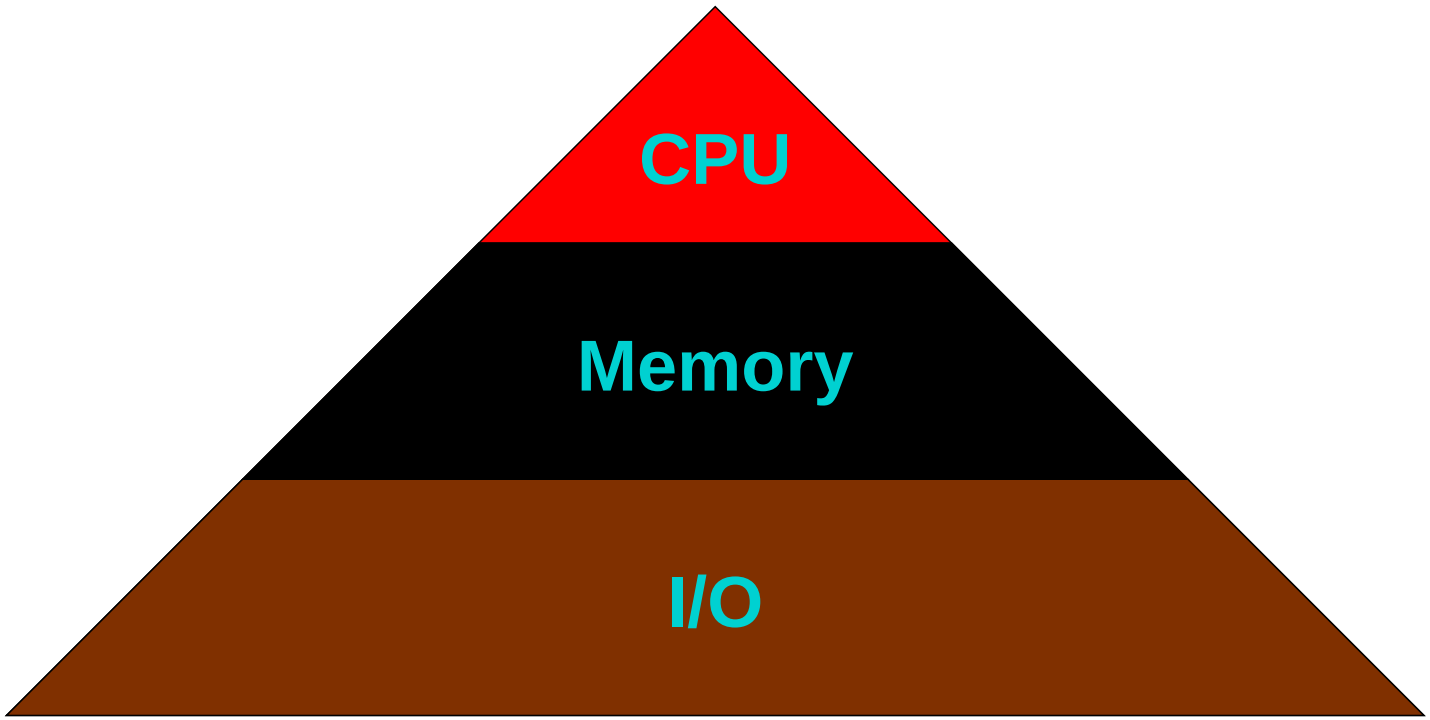
Nope!

- ~~CPU~~
- ~~Multi-threading~~
- ~~GHz~~
- ~~Pipelining~~
- ~~SMP~~
- ~~NUMA~~

Normal Server Priorities



Database Server Priorities



Why the Difference?

Traditional servers are often CPU constrained because of:

- Network overhead (http)
- Text processing (email)
- Virtual machines (application servers)
- Application code

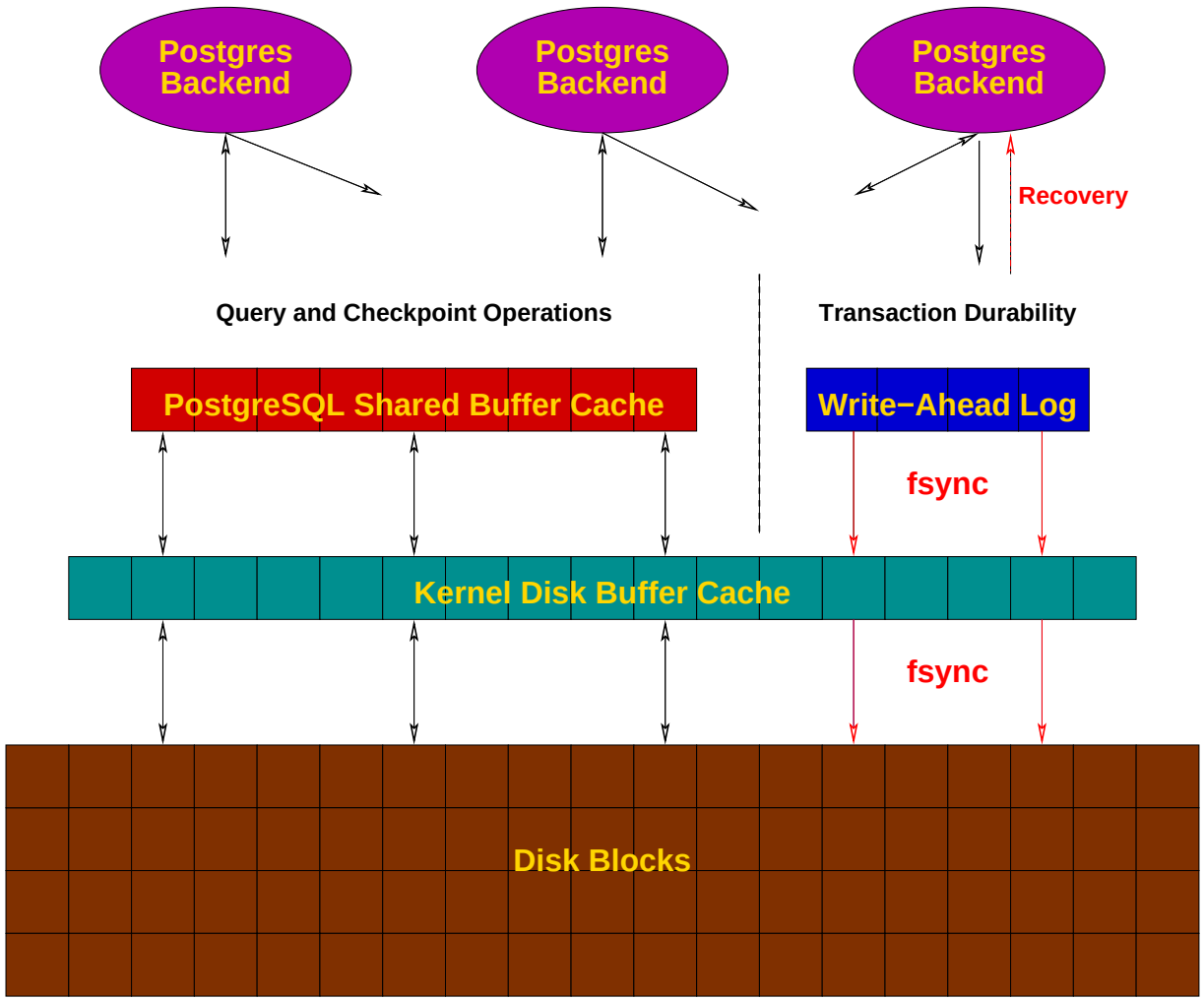
Database Server's Unique Requirements

- Sequential scans of large tables
- Index scans causing random I/O
- Unpredictable query requirements
- Reporting

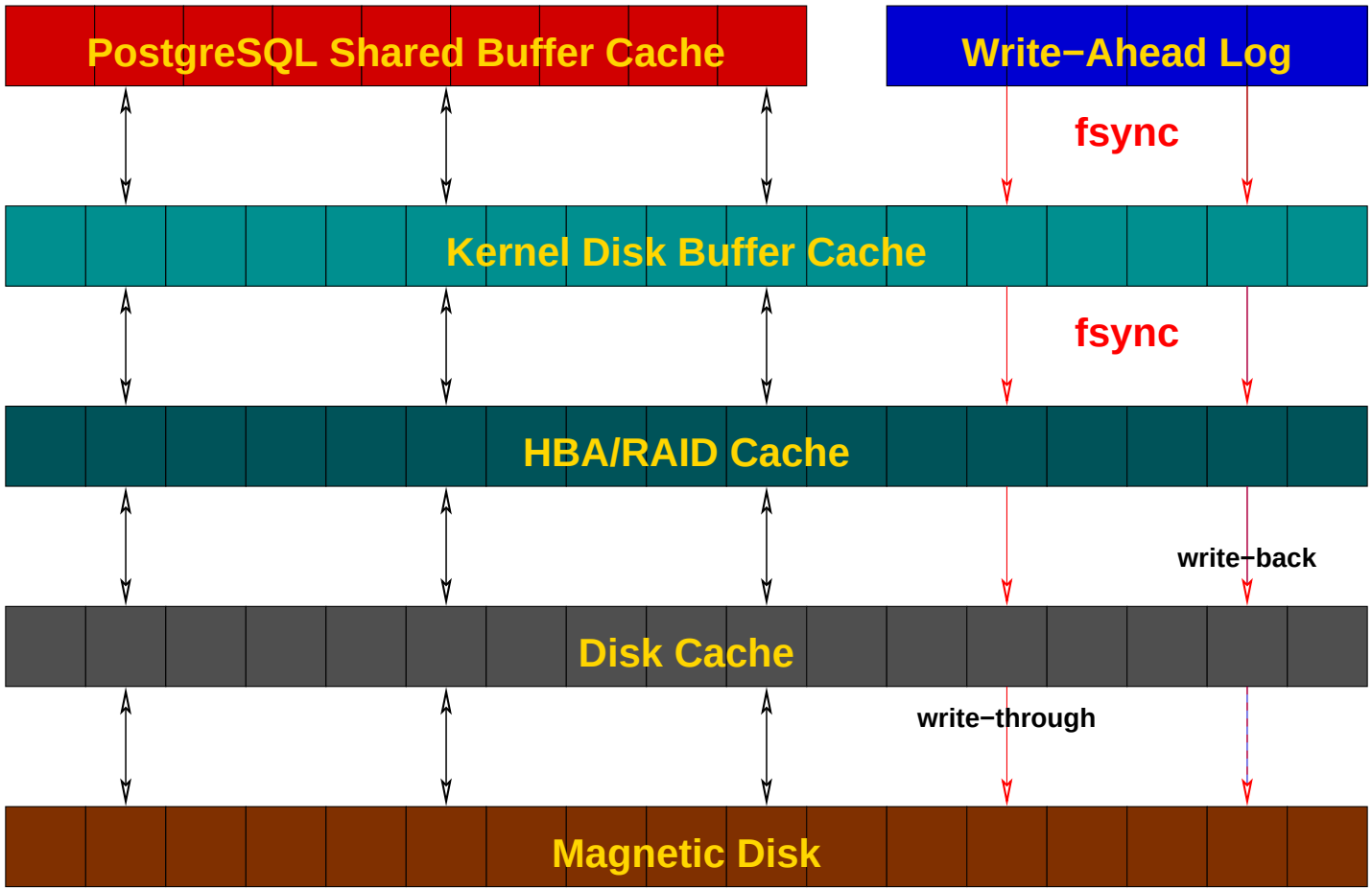
These do not require major CPU resources.

Durability Adds Even More I/O Requirements

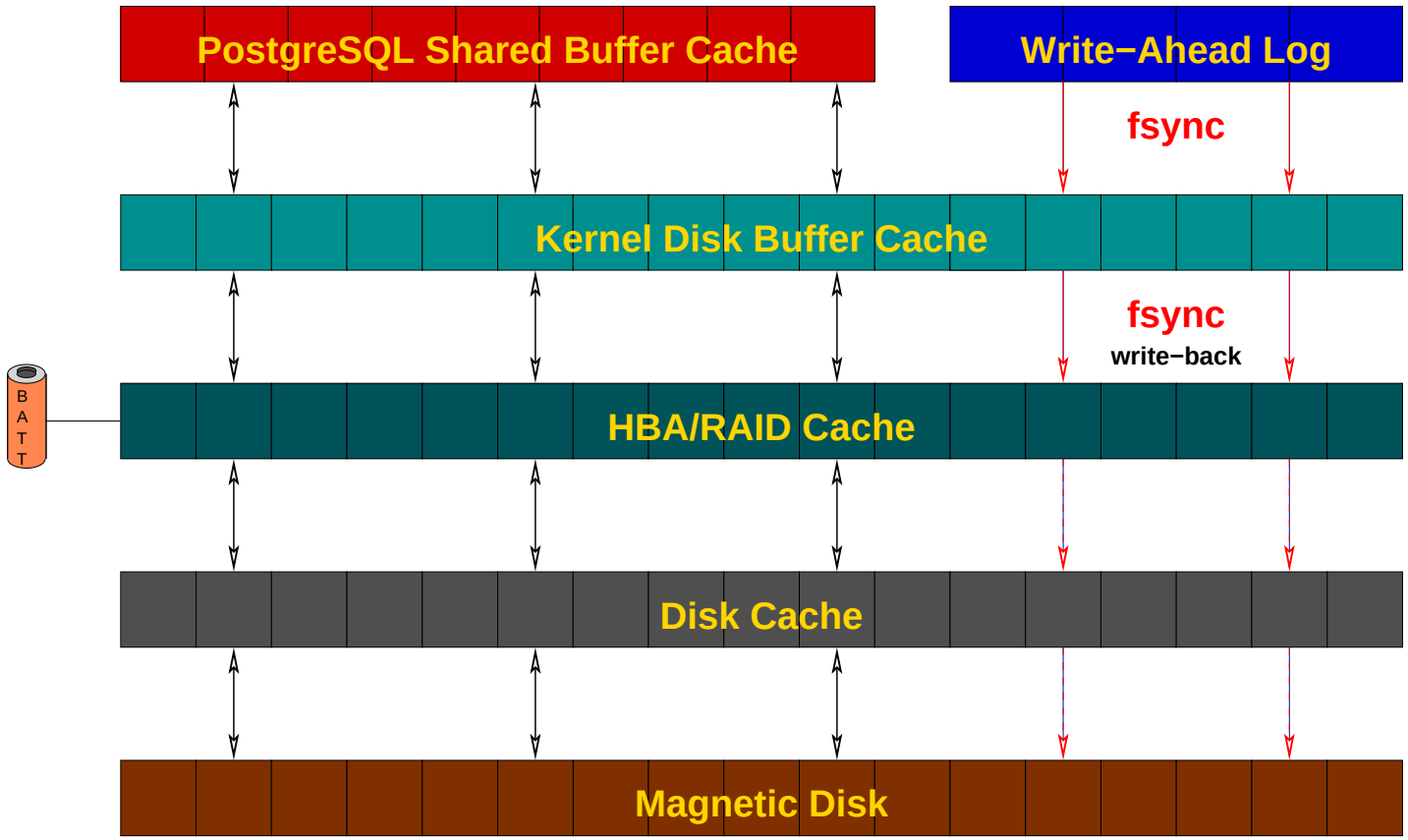
ACID (D = durability) requires committed transactions to be stored permanently. Few other server facilities must honor this requirement.



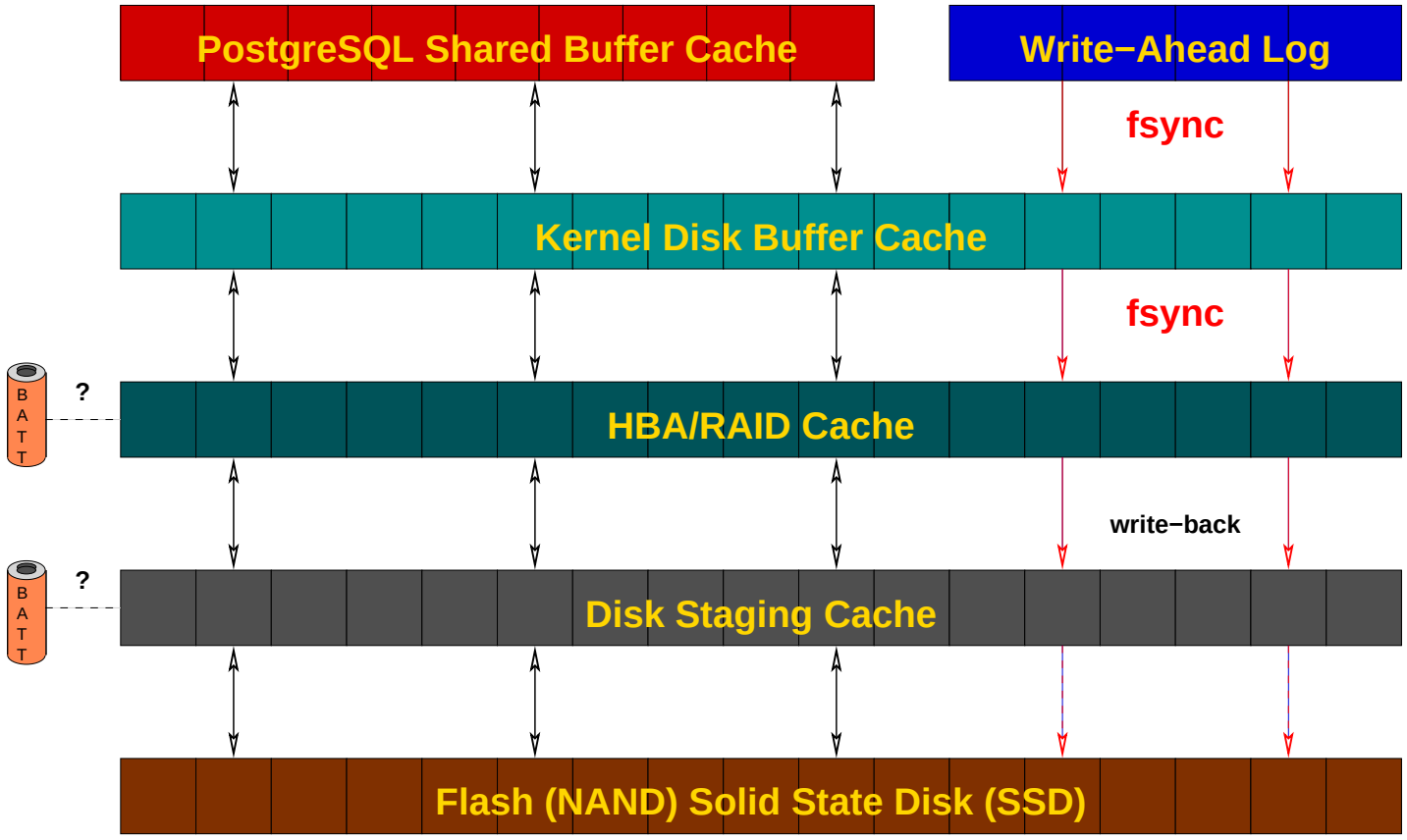
Magnetic Disk I/O Stack



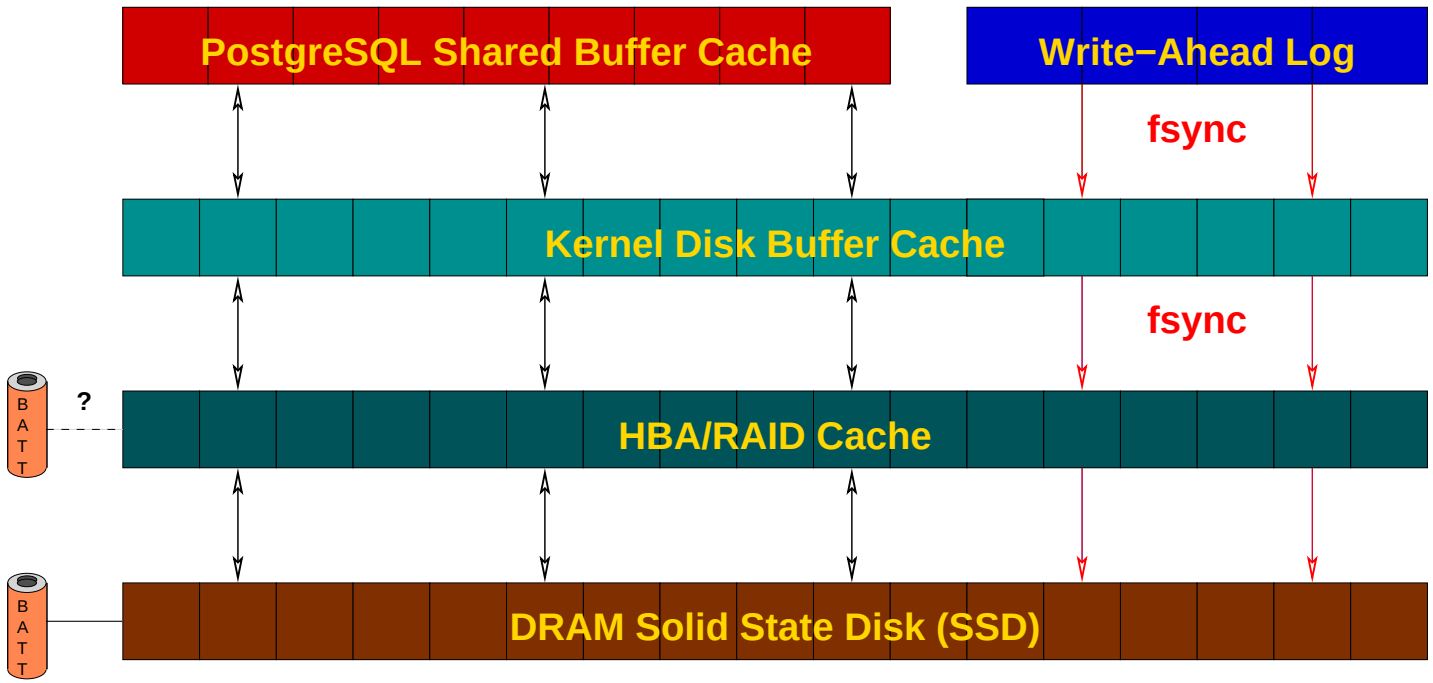
Magnetic Disk I/O Stack With BBU



Flash / NAND Storage I/O Stack



DRAM Storage I/O Stack



Write-Back vs. Write-Through Caching

- Write-back caching returns write success before passing data to lower storage layers
- Write-through caching waits for write acknowledgement from lower storage layers before returning success

Caching Layers

- HBA/RAID cache behavior is usually controlled by the HBA/RAID firmware, often conditionally based on the health of the BBU
- Storage drive cache behavior can be set by utility commands or by using certain operating system calls
- Enterprise/SAS storage devices usually default to write-through, while consumer/SATA devices usually default to write-back

HBA/RAID Caching

- HBA/RAID controllers often set storage drive caching mode to write-through
- With an HBA/RAID non-volatile cache, there is little advantage to using write-back mode on storage drives

Magnetic Disk Selection

- More small spindles is better than fewer large spindles
- RAID 5/6 is too slow for database writes
- RAID 10 is popular
- make sure SMART reporting is fully supported
- SAS/SCSI disks are usually designed for enterprise workloads, unlike SATA/ATA
  - reliability
  - error reporting
  - 24-hour operation
  - heat
  - vibration
  - http://www.intel.com/support/motherboards/server/sb/CS-031831.htm

SSDs

- Flash/NAND vs. DRAM
- Write staging area — it is not just cache
- Running a NAND SSD in write-through mode can reduce its usable life because of increased write cycles
- Best for WAL and random I/O, e.g. indexes
- Set `random_page_cost = 1.1`
- Set `effective_io_concurrency = 256`
- Intel SSD 320 Series: http://blog.2ndquadrant.com/en/2011/04/intel-ssd-now-off-the-sherr-sh.html

Filesystem Options

- xfs or ext4 over ext3
- reduce file system logging, particularly for /pg_xlog directory
- disable access (atime) recording

Battery-Backed Unit (BBU)

- Verify battery or super-capacitor (supercap) existence visually
- Typically lasts for 48-72 hours
- Some write the cache to local flash memory on power failure
- Detected battery/super-capacitor failure can disable write-back cache mode
- Requires failure monitoring
- Requires replacement

Battery-Backed Unit (BBU)

https://www.flickr.com/photos/jemimus/

Supercapacitor-Backed Unit

https://commons.wikimedia.org/wiki/File:Embedded_World_2014_SSD.jpg

Shared Storage

- SAN and NAS replace direct-attached storage (DAS) with shared storage
- Often used for easier storage management
- Shared I/O resource
- Databases often wait for I/O completion, meaning they have to contend with shared resource contention
- SAN serves block devices, NAS serves file systems

RAM

- The more RAM, the better; this reduces I/O requirements
- Ideally, five minutes of your working set
- The more RAM, the more possibility of RAM failure
- Use ECC (Error Correction Codes) RAM
  - detect errors
  - correct errors
  - report faulty memory
  - cosmic radiation

CPUs

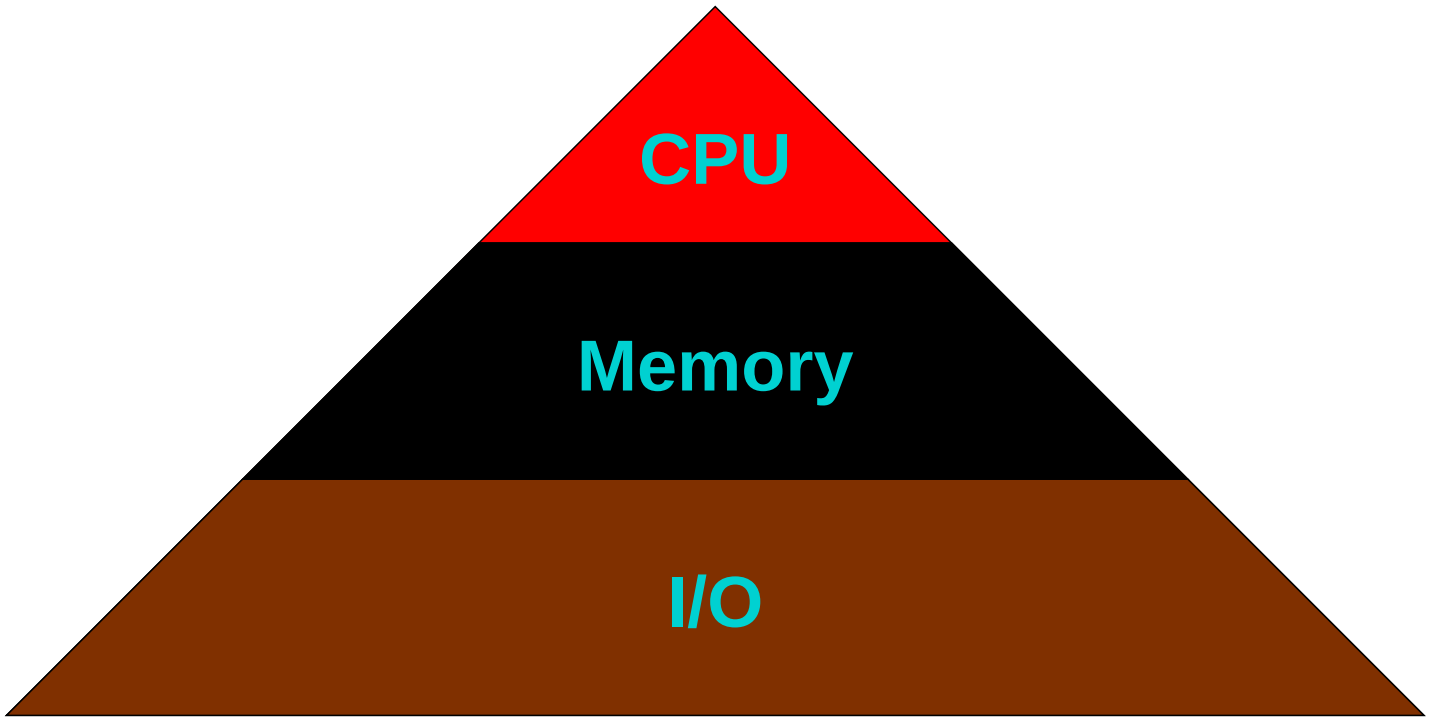
- Parallel query allows a single session to use multiple CPUs
  - Partial support added in Postgres 9.6
- Heavy use of server-side functions might generate significant CPU load
- CPUs can become a bottleneck if the entire database fits in RAM and the workload is read-only

Not the Same

Just because something has the same interface doesn't mean has the same capabilities. Compatible computer hardware is not all the same.

https://www.flickr.com/photos/cdevers/

Conclusion



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