

# Database Hardware Selection Guidelines

BRUCE MOMJIAN



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.

*Creative Commons Attribution License*

*<http://momjian.us/presentations>*

*Last updated: September, 2018*

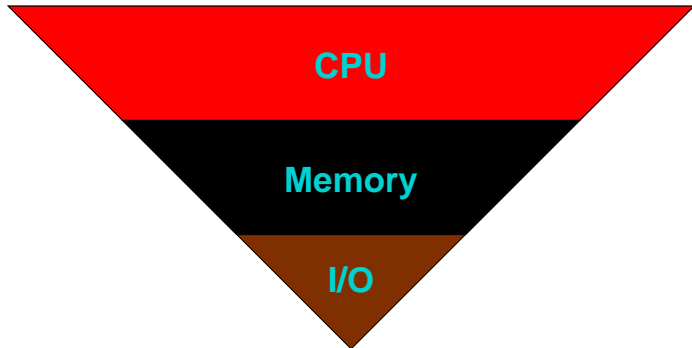
# Outline

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

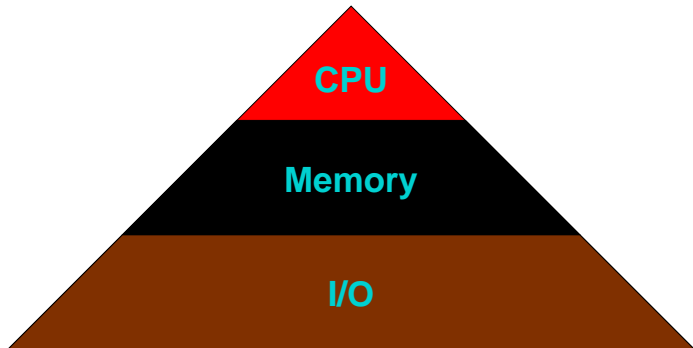
# Nope!

- ▶ ~~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

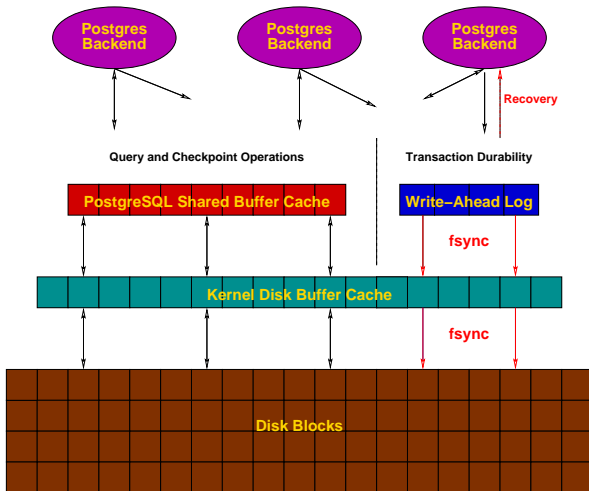
# Database Server's Unique Requirements

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

These do not require major CPU resources.

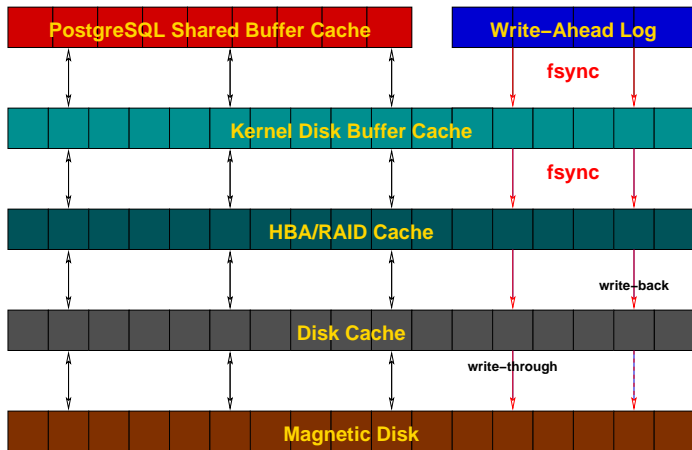
# Durability Adds Even More I/O Requirements

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

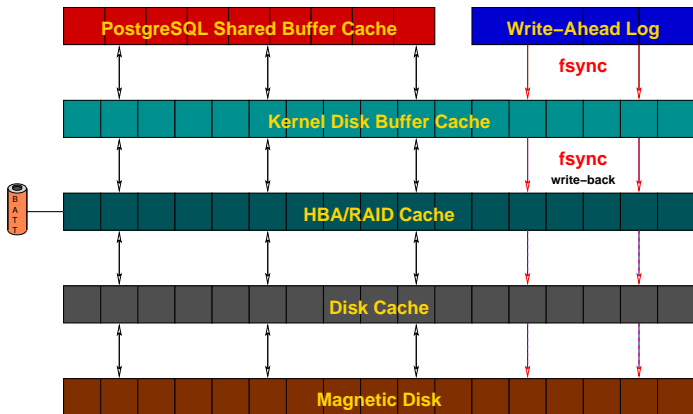




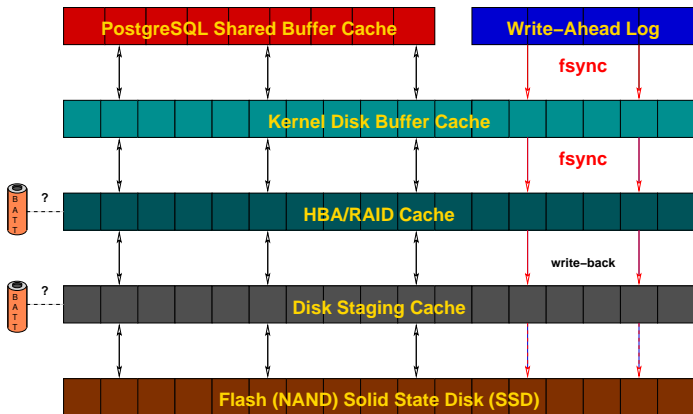
# Magnetic Disk I/O Stack



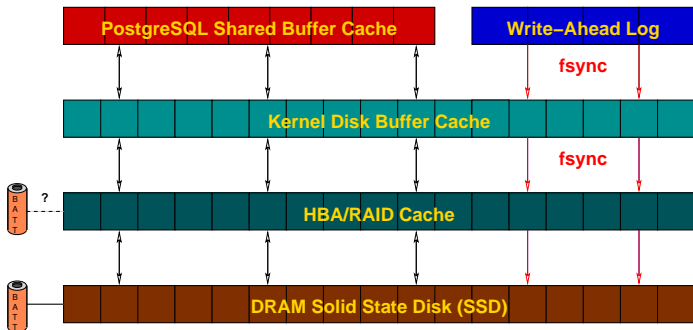
# Magnetic Disk I/O Stack With BBU



# 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>

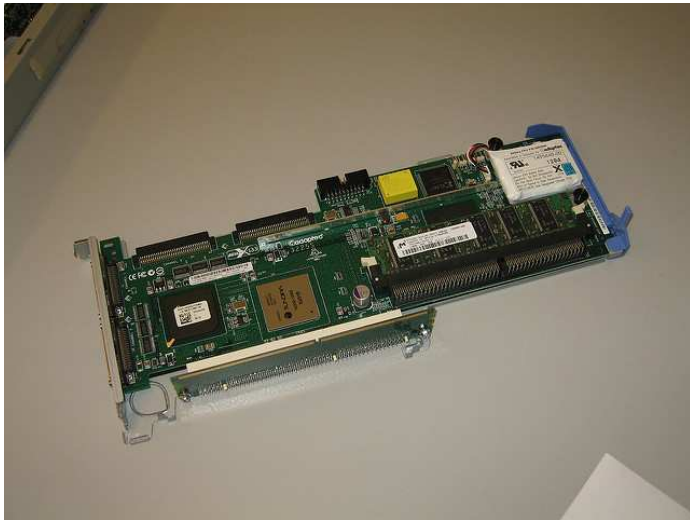
# Filesystem Options

- ▶ xfs or ext4 over ext3
- ▶ reduce file system logging, particularly for /pg\_wal 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](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

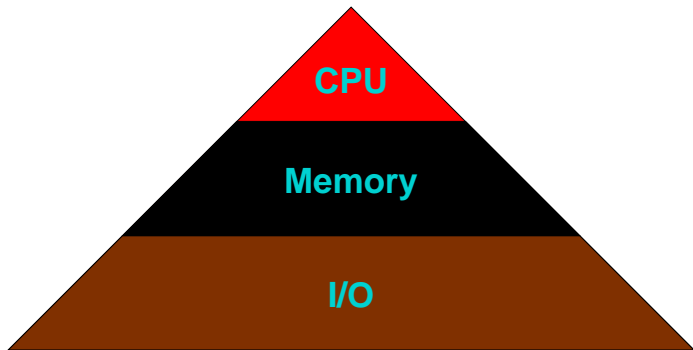


# Not the Same



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

# Conclusion



*<http://momjian.us/presentations>*