

# Database Health and Performance

(AKA I can **prove** it's not my system's fault!)

SQL Saturday Chicago – April 13, 2013

**David Klee** – Solutions Architect (@kleegeek)



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## About HoB

- ▣ Founded in 1998
- ▣ Partner-Focused Strategy
- ▣ House of Brick Key Services
  - ▣ **Virtualization and Cloud Computing — VBCA**
  - ▣ **Replatforming and Data Migration**
  - ▣ **Managed Services**



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## About Me



**vmware**  
CERTIFIED

ADVANCED  
PROFESSIONAL 5

DATA CENTER  
DESIGN

**David Klee**

 @kleegeek

 bit.ly/HoBSA

davidklee.net

 gplus.to/kleegeek

 linkedin.com/a/davidaklee



Database Administrator 2008

Database Administrator on SQL Server® 2005

Database Developer 2008

- ▣ SQL Server on VMware practice lead
- ▣ Experience in VMware, Microsoft, Linux, networking, security, application development technologies

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## Average Day

▣ 8:15 AM: "My app is running slow! What did you do to it?!"

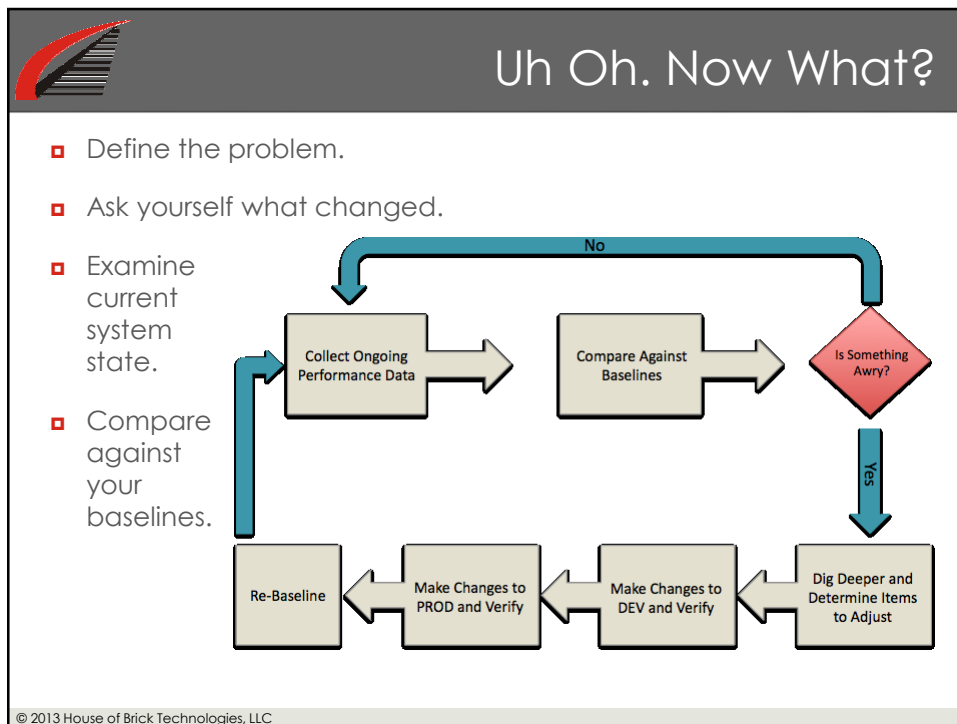
(App owner and what he wants to do to your systems)





**How can you prove that your systems are running optimally?**

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## Some Best Practices

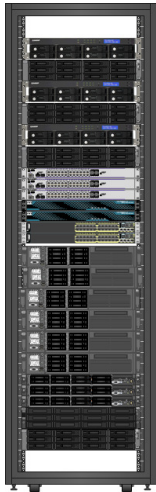
- ▣ Hardware
  - ▣ Storage
  - ▣ Interconnects
- ▣ Virtualization
- ▣ Operating System
- ▣ SQL Server
  - ▣ Instance
  - ▣ Database
  - ▣ Maintenance



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## Best Practices - Infrastructure

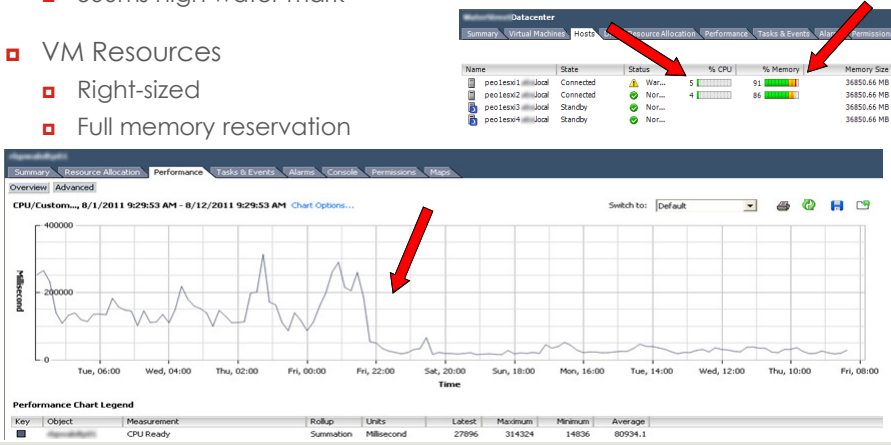
- ▣ Hardware
  - ▣ Set power management to Maximum Performance
  - ▣ Up-to-date BIOS, hardware drivers
- ▣ Storage
  - ▣ IOMeter – At least 60MB/s in all tests
  - ▣ SQLIO – latency no greater than 25ms
- ▣ Interconnects
  - ▣ Fastest storage fiber and Ethernet you can get
  - ▣ Multiple paths a requirement
  - ▣ Iperf to determine if you have problems



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## Best Practices - Virtualization

- ▣ CPU Utilization
  - ▣ CPU Ready time
  - ▣ 300ms average
  - ▣ 500ms high water mark
- ▣ Memory Utilization
  - ▣ No host overcommitment!
  - ▣ No ballooning!
- ▣ VM Resources
  - ▣ Right-sized
  - ▣ Full memory reservation

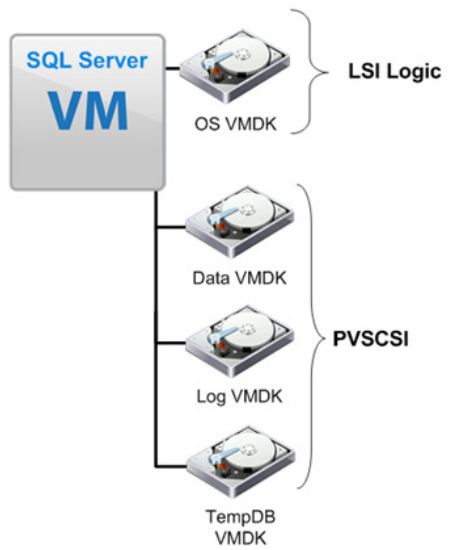


The screenshot shows the VMware vSphere interface. The top section displays a table of VMs with columns for Name, State, Status, % CPU, % Memory, and Memory Size. Below this, a performance chart for 'CPU/Custom...' shows 'CPU Ready' percentage over time. A red arrow points to a peak in the CPU Ready time chart.

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## Best Practices - Virtualization

- ▣ Storage
  - ▣ Check stats for path and datastore overload
  - ▣ Latency < 25ms
- ▣ PVSCSI driver for all non-OS drives
- ▣ Partition alignment (not just Windows Server 2003)
- ▣ Multipathing driver



The diagram illustrates the storage configuration for a SQL Server VM. It shows a central 'SQL Server VM' box connected to four VMDK files: OS VMDK, Data VMDK, Log VMDK, and TempDB VMDK. The OS VMDK is connected to an LSI Logic controller. The Data VMDK, Log VMDK, and TempDB VMDK are connected to a PVSCSI controller.

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## Best Practices - OS


- ▣ Disks
  - ▣ NTFS 64KB allocation size
  - ▣ Check partition alignment (Windows 2003 especially)
  - ▣ Disable generation of 8.3 names (fsutil behavior set disable8dot3 1)
  - ▣ Disable last file access time tracking (fsutil behavior disableaccess 1)
- ▣ System
  - ▣ Antivirus exclusions for MDF, NDF, LDF, BAK set (<http://support.microsoft.com/kb/309422>)
- ▣ SQL Server Services
  - ▣ Enable Lock Pages in Memory
  - ▣ Instant File Initialization
- ▣ Perfmon
  - ▣ Set to always collect perf counters every 5m
  - ▣ Rotate log files nightly



**Windows Server 2008 R2**

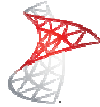


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## Best Practices – SQL Server

- ▣ Set min and max instance memory settings
- ▣ Optimize for Ad-hoc Workloads
- ▣ TempDB data files
  - ▣ More than one (# cores?)
  - ▣ Grow at same rate
- ▣ Watch for high log file VLF counts
- ▣ Agent system alerts – severities 17-25, 823-825
  - ▣ Default Operator set to distribution group



**Microsoft SQL Server 2008 R2**



**Microsoft SQL Server 2012**

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## Best Practices – SQL Server

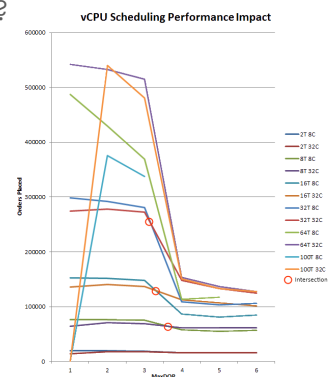
- ▣ Proper Maintenance is a Must!
- ▣ Fantastic database maintenance solution – [ola.hallengren.com](http://ola.hallengren.com)
  - ▣ Backups
  - ▣ Indexes / Statistics
  - ▣ Integrity Checks
  - ▣ Work file cleanup
- ▣ Configure email notifications and set default operator
- ▣ Demo (1)

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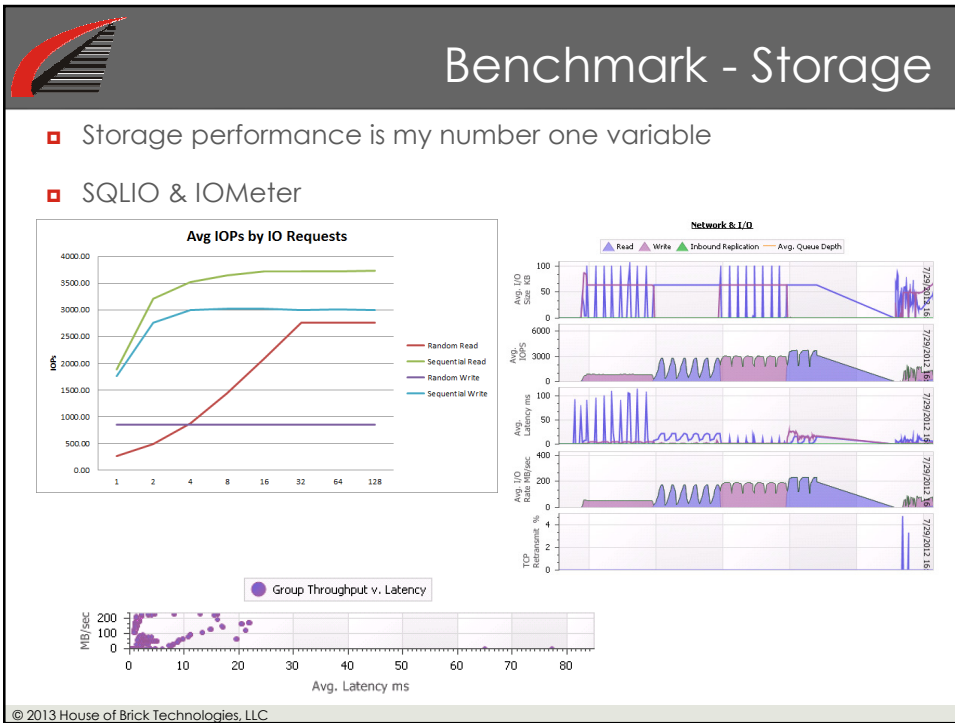


## Getting Started - Benchmarking

- ▣ Must know how to benchmark so you can establish baselines
- ▣ Repeatable process to get point in time performance metrics
- ▣ Benchmarks affect the speed of the system during the test!
- ▣ What changes between tests / iterations?
- ▣ What to benchmark?
  - ▣ Subsystem speed
  - ▣ Objective SQL Server instance speed
  - ▣ Known process / job performance and runtimes
  - ▣ Query runtimes / impact
  - ▣ Application performance



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## Benchmark – SQL Server

- DVDStore
  - <http://linux.dell.com/dvdstore>

Threads	Core x GHz	VM		Itanium Physical		8CPU VM to Avg. Itanium Improvement
		8x2GHz	32x2GHz	8x1.6GHz Run 1	8x1.6GHz Run 2	
	MaxDOP	HP Orders	HP Orders	Itanium Orders	Itanium Orders	
2	1	19277	13589	15612	12853	35.44%
2	2	19251	17858	16368	17553	13.50%
2	3	18841	17453	17214	18209	6.38%
2	4	15839	15640	15147	18306	-5.31%
2	5	15953	15779	10201	16866	17.88%
2	6	16263	16055		17596	-7.58%
8	1	76590	63910	62896	60789	23.85%
8	2	76592	70705	69392	71523	8.71%
8	3	75441	69335	65737	69184	11.83%
8	4	57508	61412	44123	71918	-0.88%
8	5	55021	61579	42442 (extrapolated)	67073	0.48%

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## Benchmark – DB Performance

- ▣ Every environment is different!
- ▣ Reports / Jobs / Etc.
  - ▣ Average Runtimes
- ▣ Query Performance
  - ▣ CPU Impact
  - ▣ Memory Impact
  - ▣ Storage Impact
  - ▣ TempDB Impact
- ▣ Application owners should be involved in benchmarking process
- ▣ Tools
  - ▣ Perfmon
  - ▣ Extended Events
  - ▣ Simple things:
    - ▣ Set statistics io on/off
    - ▣ Set statistics time on/off
  - ▣ Demo (2)

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## Baselines

- ▣ Creating a baseline != Tuning Time
- ▣ Baseline = Averages and peaks during routine activities
- ▣ Can help predict growth and resource contention
- ▣ Establish performance thresholds and high / low water marks
- ▣ Update your baselines after major system changes and/or fixed period of time
- ▣ Be consistent in your approach.
- ▣ Helpful to create a baseline repository
  - ▣ <http://www.sql-server-performance.com/2010/baseline-repository/>

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## Running Baselines - Perfmon

- ▣ Create your own constant, running system baseline
- ▣ Record every 5m, cycle log files nightly

### Counters:

Memory – Pages/sec  
 Network Interface – Bytes total/sec  
 Physical Disk – Disk Transfers/sec  
 Processor – % Processor Time  
 SQLServer:Access Methods – Full Scans/sec  
 SQLServer:Buffer Manager – Buffer Cache Hit Ratio  
 SQLServer:Databases Application Database – Transactions/sec  
 SQLServer:General Statistics – User Connections  
 SQLServer:Latches – Average Latch Wait Time  
 SQLServer:Locks – Average Wait Time  
 SQLServer:Locks – Lock Timeouts/sec  
 SQLServer:Locks – Number of Deadlocks/sec  
 SQLServer:Memory Manager – Memory Grants Pending

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## Getting Started with Benchmarks & Baselines

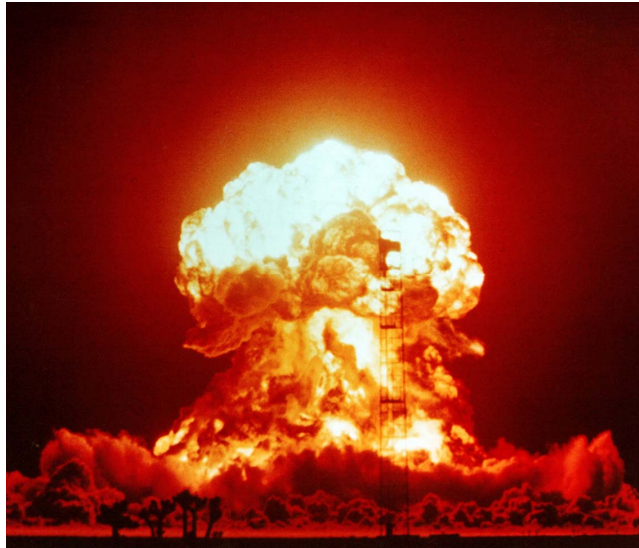
- ▣ **Easiest Places to Start:**
- ▣ Glenn Berry – SQL Server Diagnostics Queries
  - ▣ <http://sqlserverperformance.wordpress.com>
- ▣ Brent Ozar – SQL Blitz
  - ▣ <http://www.brentozar.com/blitz>
- ▣ You know your systems. Baseline your system performance frequently.
- ▣ What objective application metrics can you repetitively measure?



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## Back to the Problem At Hand...

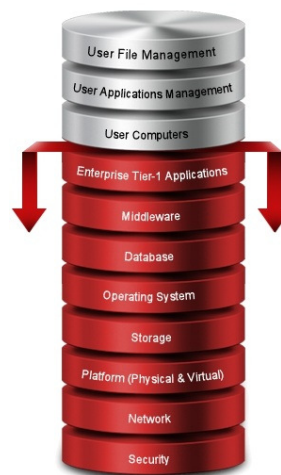


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## Performance Triage

- ▣ Performance triage starts with comparing real-time stats against your baselines.
- ▣ Work Down the Stack
  - or
- ▣ Work Up the Stack
  - ▣ Hardware, Storage, and Virtualization
  - ▣ Operating System
  - ▣ SQL Server instance
  - ▣ Database(s)
  - ▣ Queries




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## System Stack

- ▣ Raw Server Health
  - ▣ Hardware alarms / warnings / failures
  - ▣ Interconnect failures / dead paths
  - ▣ Networking overloaded or degraded network path
  - ▣ Sub-par raw storage performance
    - ▣ IOmeter & SQLIO
- ▣ Virtualization Health
  - ▣ Host CPU and memory states
  - ▣ High CPU Ready and/or memory ballooning
  - ▣ Host resource overcommittment
- ▣ Operating System
  - ▣ Check Windows Event Log



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## CPU Bottlenecks

- ▣ Raw CPU usage by instance is very high
- ▣ Signal wait statistic is greater than 25% of total waits
- ▣ Plan re-use is less than 90%
- ▣ Parallel wait statistic CXPACKET is greater than 10% of total waits
- ▣ High work queue count for long duration
- ▣ Demo (3)

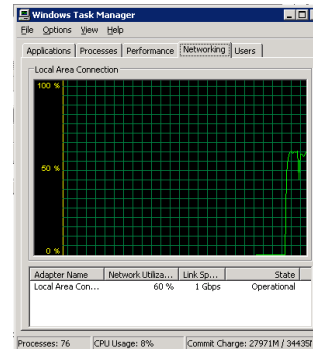
Query Source: <http://blog.sqlauthority.com/2009/08/17/sql-server-measure-cpu-pressure-cpu-business/>

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## Network Problems

- ▣ You have high network latency
- ▣ You have dropped packets
- ▣ You have maxed out your network bandwidth
- ▣ Wait stats to check
  - ▣ ASYNC\_IO\_COMPLETION
  - ▣ ASYNC\_NETWORK\_IO
- ▣ Task manager / Perfmon on server
- ▣ Use iperf to check network paths



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## Memory Pressure

- ▣ Page life expectancy is low.
  - ▣ 300 is NOT the magic number!
  - ▣ One Suggestion: [Data Cache Size (GB) / 4GB] x 300
  - ▣ See <http://www.sqlskills.com/blogs/jonathan/post/Finding-what-queries-in-the-plan-cache-use-a-specific-index.aspx> for more details
- ▣ Buffer Cache Hit ratio < 90%
- ▣ High Checkpoint pages / sec & Lazy Writes / sec
- ▣ Ring Buffers
  - ▣ [http://sqlskills.com/blogs/jonathan/post/Identifying-External-Memory-Pressure-with-dm\\_os\\_ring\\_buffers-and-RING\\_BUFFER\\_RESOURCE\\_MONITOR.aspx](http://sqlskills.com/blogs/jonathan/post/Identifying-External-Memory-Pressure-with-dm_os_ring_buffers-and-RING_BUFFER_RESOURCE_MONITOR.aspx)
- ▣ Demo (4)
- ▣ Read More:
  - ▣ <http://www.mssqltips.com/sqlservertip/2304/how-to-identify-microsoft-sql-server-memory-bottlenecks/>
  - ▣ <http://blog.sqlauthority.com/2010/12/10/sql-server-finding-memory-pressure-external-and-internal/>

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## I/O Performance

- ▣ Exceptionally high average disk seconds per read
- ▣ High volume of disk stalls and/or high disk stall wait times
- ▣ High wait stats around:
  - ▣ ASYNCH\_IO\_COMPLETION
  - ▣ IO\_COMPLETION
  - ▣ LOGMGR
  - ▣ PAGEIOLATCH\_\*
  - ▣ WRITELOG
- ▣ Disk read / write stalls high
- ▣ Your triage benchmark falls well below your established baseline
- ▣ Get more reports from your storage administrator and investigate further



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## Indexes and Statistics

- ▣ No index? Table scans = slow performance.
- ▣ No stats? The optimizer has to guess!
- ▣ Check for:
  - ▣ Index fragmentation is high
  - ▣ Statistics are out of date
  - ▣ High number of 'bad' indexes
  - ▣ Execution plan missing index warnings / bad stats
    - ▣ Is estimated number of rows WAY off from actual?
  - ▣ (Bad) DTA query index recommendations that **someone** applied
  - ▣ Is Auto Create Statistics set to off?
- ▣ Demo (5)
- ▣ Read More:
  - ▣ <http://www.simple-talk.com/sql/database-administration/brads-sure-guide-to-indexes/>
  - ▣ <http://www.simple-talk.com/sql/performance/sql-server-statistics-problems-and-solutions/>

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## Bad Queries

- ▣ Tools: DMVs and Profiler
- ▣ Obvious places to start:
  - ▣ High CPU utilization
  - ▣ High I/O requirements
  - ▣ High memory consumption
  - ▣ Execution counts
- ▣ Missing / bad indexes and/or statistics
- ▣ Fetching more columns / rows than needed (*select \* from dbo.x*)
- ▣ Bad execution plan
 

Include Actual Execution Plan Ctrl+M

  - ▣ `select plan_handle, creation_time, last_execution_time, execution_count, qt.text  
FROM sys.dm_exec_query_stats qs  
CROSS APPLY sys.dm_exec_sql_text (qs.[sql_handle]) AS qt`
  - ▣ `DBCC FREESYSTEMCACHE(plan handle)` to clear it

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## Locking & Blocking

- ▣ A top wait statistic is LCK\_M\_XX AND the average time is high
  - ▣ `sys.dm_os_wait_stats`
- ▣ High number of deadlocks
- ▣ Block process report reports long blocks
- ▣ High average row lock or latch waits
- ▣ Long running transactions
- ▣ Index contention
  - ▣ `sys.dm_db_index_operational_stats`
- ▣ Read More:
  - ▣ <http://www.sqlskills.com/BLOGS/PAUL/post/Wait-statistics-or-please-tell-me-where-it-hurts.aspx>

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## Database Origins

- ▣ Is the database that is performing poorly a third-party database, or one where you have NO control over the design?
- ▣ If third-party, will the vendor support you changing things?
  - ▣ Doubtful.
  - ▣ Will application support be dropped if you change anything?
- ▣ If custom, can you change things?
  - ▣ Maybe. It depends.
- ▣ If third-party, is your organization willing to 'void the warranty'?
- ▣ Plan Guide substitutions?



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## Bad Database Design

- ▣ Too many table joins for frequent queries
- ▣ Table too wide (many null columns without sparse columns)
- ▣ Not enough appropriate indexes
- ▣ Too many inappropriate ones
- ▣ Indexes too huge – check for GUIDs in primary key
- ▣ No / bad normalization
- ▣ No foreign keys / primary keys / relationships
- ▣ Inappropriate isolation level

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## Put Up or (Don't) Shut Up

- ▣ Document your findings thoroughly and accurately
- ▣ Don't just point another finger if it is not your system's fault
  - ▣ Provide evidence of the problem
  - ▣ Identify the system stack component at fault
  - ▣ Assist with remediation as needed
  - ▣ Provide validation when resolved
- ▣ If the problem is in your system, acknowledge it and continue
  - ▣ Remediate at first possible opportunity
  - ▣ Develop long term plan for solution, not just a patch
  - ▣ Append monitoring to try to proactively alert if it happens again
- ▣ Remember
  - ▣ This is an art AND a science. Know SQL Server internals. Know your environment, apps, and how they are used.

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## Questions



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## HoB Contacts

- ▣ **Jim Ogborn (Northwest & Mid-South)**  
**VP, Client Solutions**  
jogborn@houseofbrick.com  
402-445-0764 x104
- ▣ **Bob Lindquist (West & Southwest)**  
**VP, Client Solutions**  
blindquist@houseofbrick.com  
480-414-9134
- ▣ **Jon Shields (Central)**  
**Director, Account Solutions**  
jshields@houseofbrick.com  
847-507-1693
- ▣ **David Klee**  
**Solutions Architect**  
Twitter @kleegeek  
dklee@houseofbrick.com  
402-445-0764 x133
- ▣ **KC Alvano (East)**  
**Director, Account Solutions**  
kcalvano@houseofbrick.com  
703-395-3138

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