

# Database Health and Performance

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

SQL Saturday Lincoln – October 6, 2012

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



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## About House of Brick

- 14 year old Omaha-based company
- Leader: Tier-1 VMware, Database Performance
- Rock-solid reputation for optimizing the entire system stack to maximize Tier-1 performance
- House of Brick key service value components
  - Hybrid/private cloud architectures for complex Tier-1 workloads
  - Legacy to virtualization, and private/hybrid cloud system replatforming
  - SQL Server and Oracle virtualization specialties
  - Short term assessments and proof-of-concept projects
  - Long-term project analysis, PM, implementation, & validation



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## About Me



**vmware**  
 CERTIFIED  
 ADVANCED  
 PROFESSIONAL 5  
 DATACENTER  
 DESIGN

**Microsoft**  
 CERTIFIED  
 IT Professional


### David Klee

Twitter: @kleegeek  
 Blog: davidklee.net

Database Administrator 2008  
 Database Administrator on SQL Server® 2005  
 Database Developer 2008

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


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## Average Day

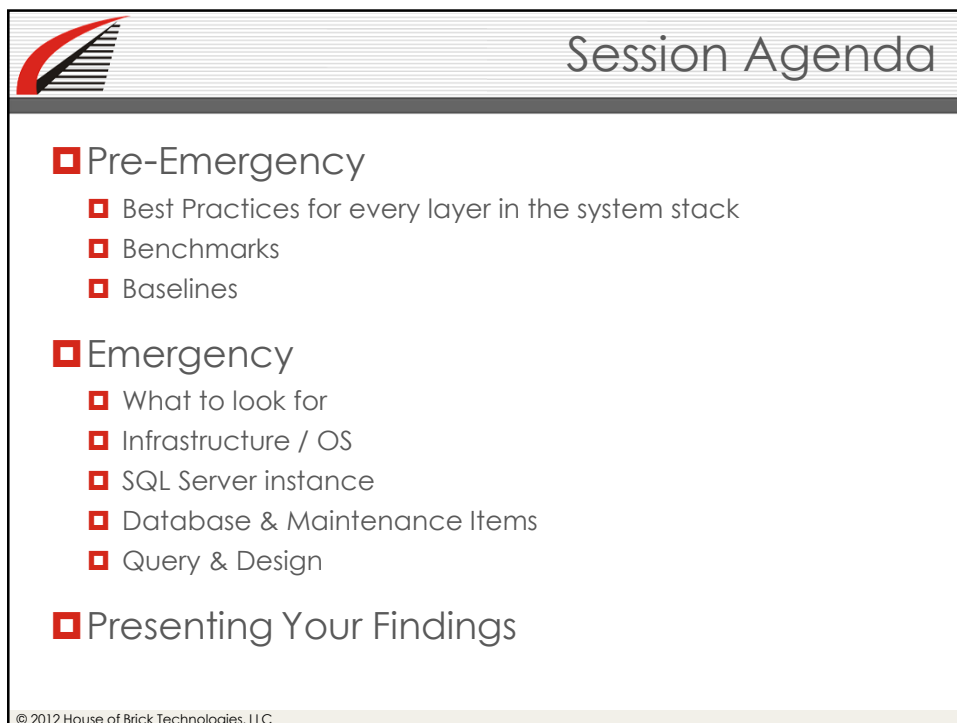
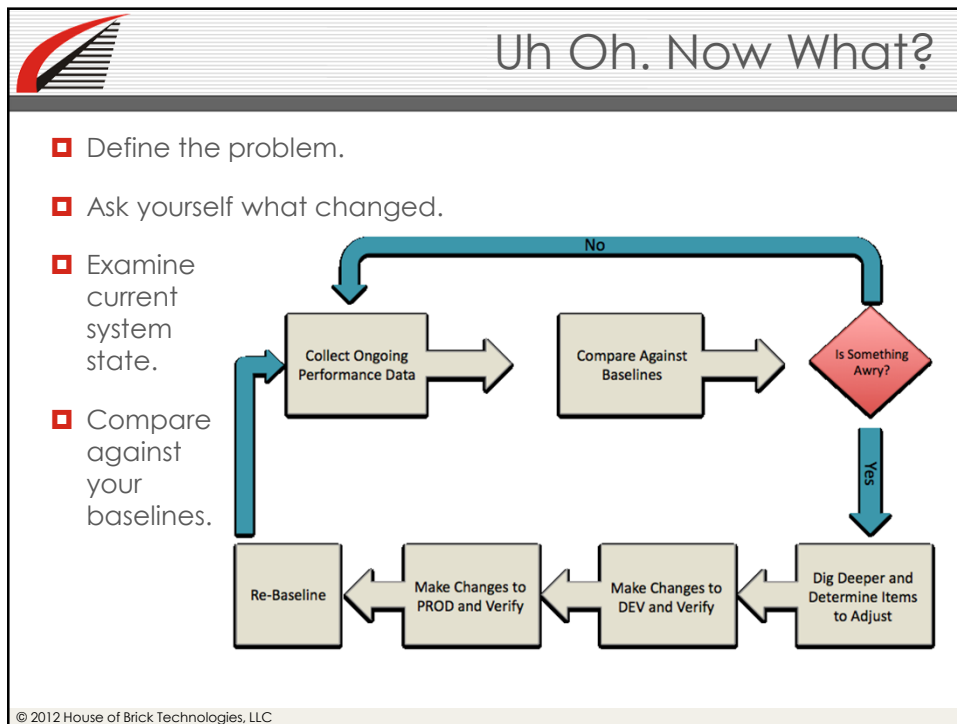
▣ 8:15 AM: "My app is running slow! What did you do to it?!"

(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

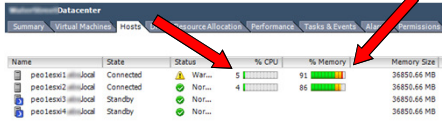
- Hardware
  - Set power management to Maximum Performance
  - Up-to-date BIOS, hardware drivers
- Storage
  - IOMeter – At least 60MB/s in all tests
  - SQLIO – latency no greater than 25ms
- Interconnects
  - Fastest storage fiber and Ethernet you can get
  - Multiple paths a requirement
  - Iperf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



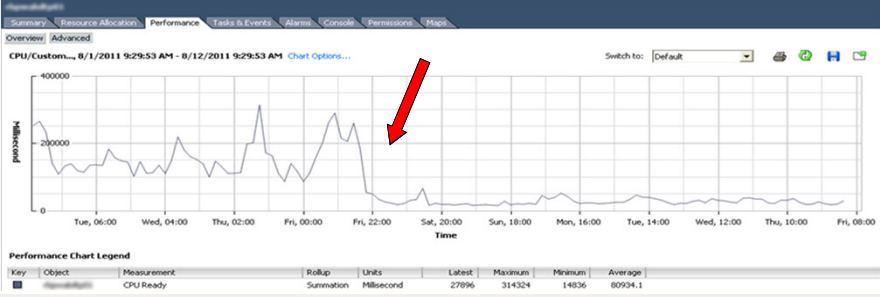
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## Best Practices - Virtualization

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



Name	Status	% CPU	% Memory	Memory Size
peoples1@linux	Connected	War...	91	36850.66 MB
peoples2@linux	Connected	Nor...	86	36850.66 MB
peoples3@linux	Standby	Nor...		36850.66 MB
peoples4@linux	Standby	Nor...		36850.66 MB



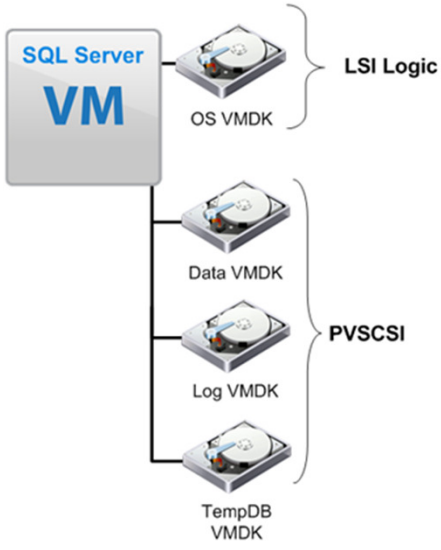
Performance Chart Legend

Key	Object	Measurement	Rollup	Units	Latest	Maximum	Minimum	Average
■	Hosts	CPU Ready	Summation	Millisecond	27896	314324	14836	60934.1

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## Best Practices - Virtualization

- ▣ Storage
  - ▣ Check stats for path and datastore overload
  - ▣ Latency < 30ms
- ▣ PVSCSI driver for all non-OS drives
- ▣ Partition alignment (not just Windows Server 2003)
- ▣ Multipathing driver



SQL Server VM


OS VMDK (LSI Logic)

Data VMDK (PVSCSI)

Log VMDK (PVSCSI)


TempDB VMDK (PVSCSI)


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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 (Enterprise ed. only)
  - ▣ Instant File Initialization
- ▣ Perfmon
  - ▣ Set to always collect perf counters every 5m
  - ▣ Rotate log files nightly

  
**Windows Server® 2008 R2**


  
**Windows Server 2012**


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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

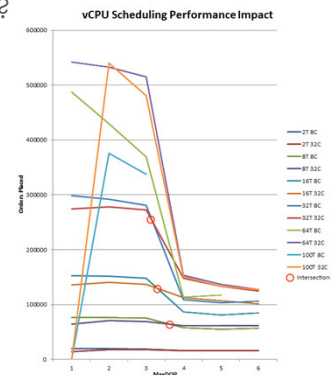
- ▣ Proper Maintenance is a Must!
- ▣ Fantastic database maintenance solution – [ola.hallengren.com](http://ola.hallengren.com)
  - ▣ Backups
  - ▣ Indexes / Statistics
  - ▣ Integrity Checks
  - ▣ Work file cleanup
- ▣ Configure email notifications and set default operator
- ▣ Demo (1)

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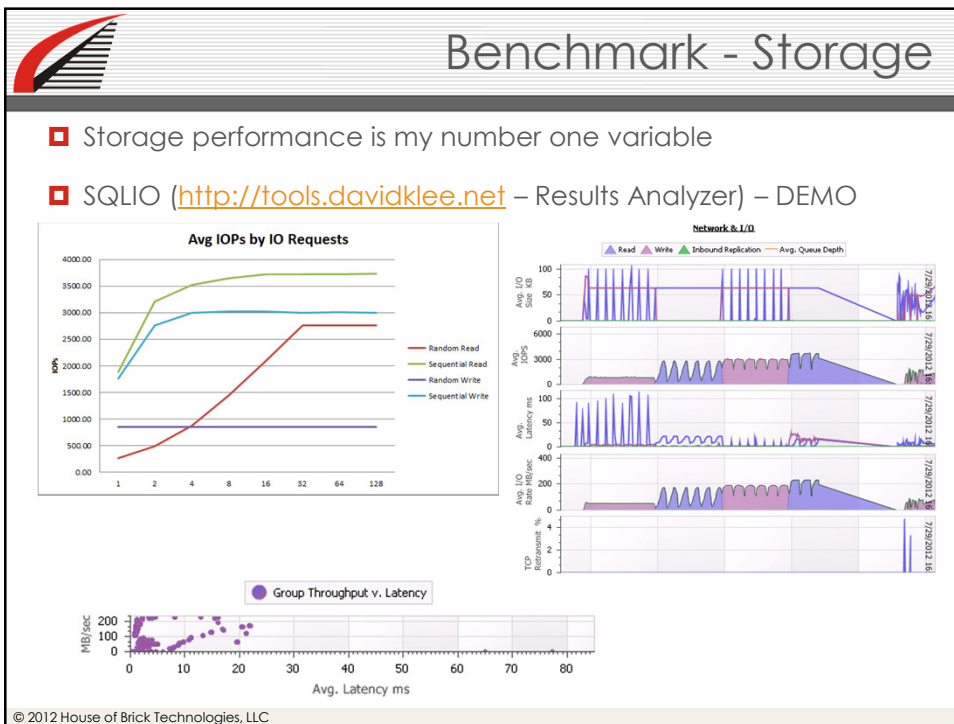


## Getting Started - Benchmarking

- ▣ 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/sql/blitz-minute-sql-server-takeovers/>
- ▣ 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
    - ▣ SQLIO Analyzer @ [tools.davidklee.net](http://tools.davidklee.net)
- ▣ 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

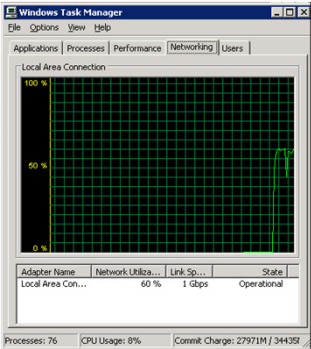
- ▣ Raw CPU usage by instance is very high
- ▣ Signal wait statistic is greater than 25% of total waits
- ▣ Plan re-use is less than 90%
- ▣ Parallel wait statistic CXPACKET is greater than 10% of total waits
- ▣ High work queue count for long duration
- ▣ Demo (3)

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




The screenshot shows the Windows Task Manager Performance tab. The 'Networking' section is selected, showing a graph of network usage over time. Below the graph, a table lists network adapters. The 'Local Area Connection' is highlighted, showing 60% network usage, a link speed of 1 Gbps, and a state of 'Operational'.

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## Memory Pressure


- ▣ Page life expectancy is low.
  - ▣ 300 is NOT the magic number!
  - ▣ One Suggestion:  $\text{[Data Cache Size (GB) / 4GB]} \times 300$
  - ▣ 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 & Lazywrites / 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 memory consumption
  - ▣ High I/O requirements
- ▣ 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 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'?



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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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## SQL Server on VMware Boot Camp

### VIRTUALIZING SQL SERVER ON VMware BOOT CAMP

**Tuesday November 6th, 2012**  
 HELD AT SQL PASS SUMMIT  
 Aspen Room  
 Sheraton Seattle Hotel  
 1400 Sixth Avenue, Seattle, WA 98101

11:00 – 12:00 Registration, Lunch, and Networking  
 12:00 – 4:30 Boot Camp Intensive



### BOOT CAMP COURSE OVERVIEW

- Intro to SQL Server Virtualization**
  - Virtualization Trends •
  - Common Objections and Misconceptions •
- Physical Stack Fundamentals**
  - SQL Server Licensing Concepts •
  - Storage, vSphere Host, and Networking •
- Virtual Machine Layer**
  - VM and Guest Operating System Customization •
  - Virtual Storage Presentation Options •
  - Installation and Optimally Configure SQL Server •
- SQL Server on VMware Prototype**
  - Benchmarking and Baselining Performance •
  - Workload Selection •
- Beyond the Prototype**
  - Disaster Recovery and HA Options •
  - SQL Server Clustering •
  - SQL Server 2012 AlwaysOn •

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EDUCATION

More information at <http://bit.ly/Plne7f>. Register at <http://bit.ly/PUKkbO>.


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Database Health and Performance  
(AKA I can *prove* it's not my system's fault!)

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The slide has a dark gray header section containing the title "Database Health and Performance" and a subtitle "(AKA I can *prove* it's not my system's fault!)". Below this is a line of text "SQL Saturday Lincoln – October 6, 2012". The main body of the slide is white and contains the name "David Klee" and his title "Solutions Architect (@kleegeek)". Below this is the "House of Brick Technologies" logo, which features a red curved line and black horizontal lines to the left of the text "House of Brick" and "TECHNOLOGIES". A small copyright notice "© 2012 House of Brick Technologies, LLC" is at the bottom left.