It's All About the Performance, Right?

SQL PASS Performance Virtual Chapter

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House of Brick TECHNOLOGIES

About HoB

- Founded in 1998
- Partner-Focused Strategy
- House of Brick Key Services

  - **Virtualization and Cloud Computing — VBCA**
  - **Replatforming and Data Migration**
  - **Managed Services**

About David

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ADVANCED PROFESSIONAL 5
DATACENTER DESIGN

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Microsoft CERTIFIED IT Professional

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

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

Bottom Line Up Front…

- Your application users do **not** care about SAN technologies, networking, code, or databases
- Their data must be there in their apps when they click the buttons, when they want it and the way they want it
- It's your job as a DBA to:
  - Ensure that the data is accurate and available
  - Attempt to build resiliency so failures go unnoticed
  - Recover the environment ASAP during an outage
- To the business users, nothing else really matters
- … And why ***should*** they have to worry about these things?

Define Reasonable Performance

- Reasonable System Performance = Removal of all bottlenecks that are slowing a system to below acceptable levels
- Reasonable System Performance != Absolute fastest performance, no matter the situation, application, or cost
- What are acceptable levels?
- How do you determine acceptable levels?

http://www.flickr.com/photos/wearedaughters/5826575057/

Your Current Situation

Proactive (Tuning)

http://www.flickr.com/photos/mdalmuld/7385054252/

Start Here!

Reactive (Triage)

http://www.flickr.com/photos/scottcawley/7510732206/

What Can You Do Proactively?

Let's collect data!

- Baseline ongoing system performance
- Third party performance monitoring tools
- Windows Perfmon data collection
- Performance Data Warehouse
- Custom baseline repository
- Expose your bottlenecks

http://www.flickr.com/photos/seafan/7192989142/

Out of Scope?

- DBAs should be SQL Server experts, but should also be knowledgeable of the environment *around* their data
- Any of the layers can contribute to system performance degradation, but you will most likely be called first
- These layers include:
  - Storage
  - Storage interconnects
  - Any virtualization
  - Networking
  - Operating system
  - Application

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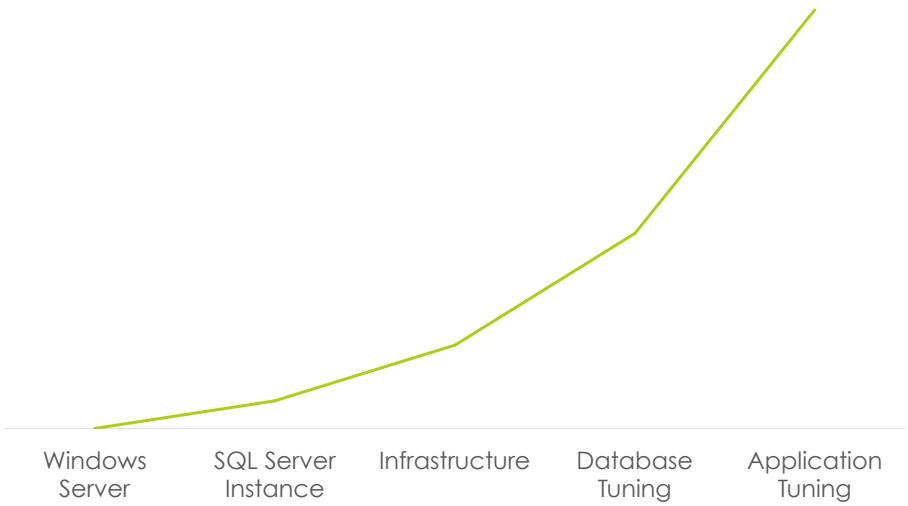
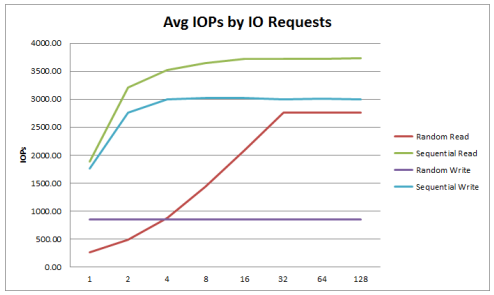
- Even if you don't directly have access to these, you *DO* have indirect access that you can test.

Performance Improvements



Benchmark Storage

- Use tools such as IOMeter and SQLIO to get a measure of your storage performance
- Focus on different workload types
- Fetch throughput (MB/s), I/Os (IOps), and latency (ms)
- See any flatlines? Might be maxing out interconnect or array itself.



Virtualization Performance

- Virtualization layer should expose Windows Perfmon counters

VMware vSphere

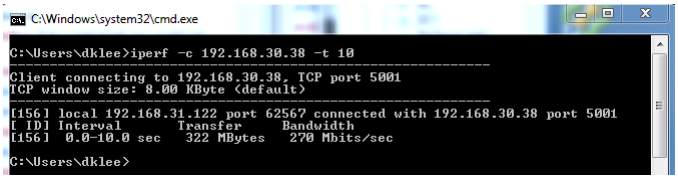
- \VM Processor\% Processor
- \VM Processor\CPU stolen time
- \VM Processor\Limit in MHz
- \VM Memory\Memory Active
- \VM Memory\Memory Ballooned
- \VM Memory\Memory Limit
- \VM Memory\Memory Used

Microsoft Hyper-V

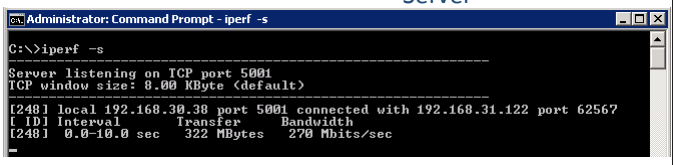
- \Hyper-V Hypervisor Logical Processor (*) \% Total Run Time
- \Hyper-V Hypervisor Logical Processor (*) \% Guest Run Time
- \Hyper-V Hypervisor Logical Processor (*) \% Hypervisor Run Time
- \Hyper-V Hypervisor Root Virtual Processor (*) \ *
- \Hyper-V Hypervisor Virtual Processor (*) \ *

Networking Performance

- Use iperf to test network throughput performance
  - Windows build at http://linhost.info/2010/02/iperf-on-windows/



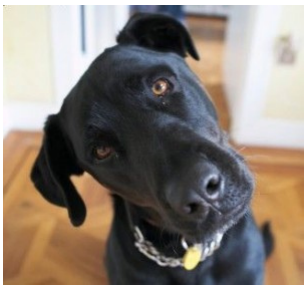
Client Server



OS Basics for DBAs

- 32 or 64 bit?
- Service Pack and patch status
- Latest BIOS and driver revisions
- Partitions
  - Alignment and block size
  - Basic, Dynamic, or GPT disk
  - Fragmentation
  - Swapping
- Non-default software (A/V, etc.)
- Windows Server quirks
  - I.E. Memory consumption during 'push' network traffic

Windows Server 2012



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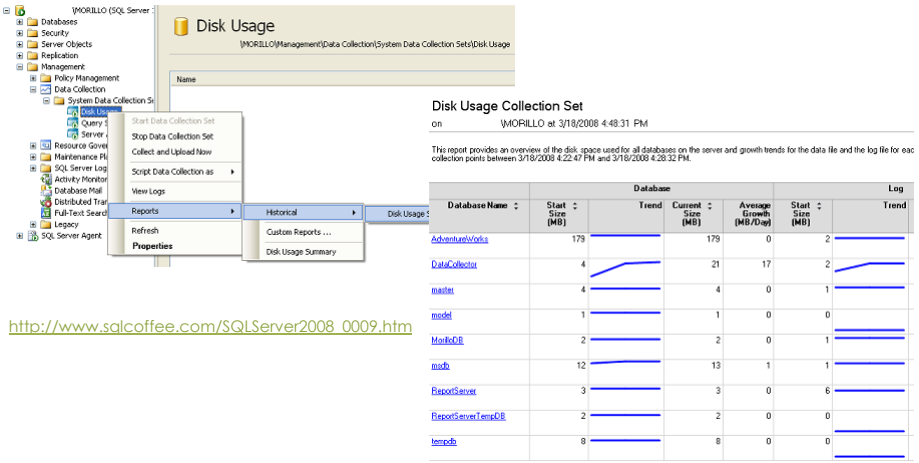
Benchmark – DB Performance

- 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
- Establish performance thresholds and high / low water marks
- Think about workloads by time of day / day of week, month, quarter, etc.

Performance Data Collector

- You should already own this!
- http://msdn.microsoft.com/en-us/library/bb677179.aspx



http://www.sqlcoffee.com/SQLServer2008_0009.htm

Third-Party Performance Tools

SQLSentry®

idera™ TOOLS FOR SQL SERVER, SHAREPOINT, AND POWERSHELL

redgate ingeniously simple tools

CONFIO SOFTWARE

QUEST SOFTWARE® Simplicity At Work™

solarwinds

embarcadero®

precise Performance intelligence from click to storage.

NOT A COMPLETE LIST!

Custom Performance Collection

- **Easiest Places to Start:**
- Glenn Berry – SQL Server Diagnostics Queries
  - http://sqlserverperformance.wordpress.com
- Brent Ozar – SQL Blitz
  - http://www.brentozar.com/blitz
- Helpful to create a baseline repository
  - http://www.sql-server-performance.com/2010/baseline-repository/

And Now For Reactive Activities…

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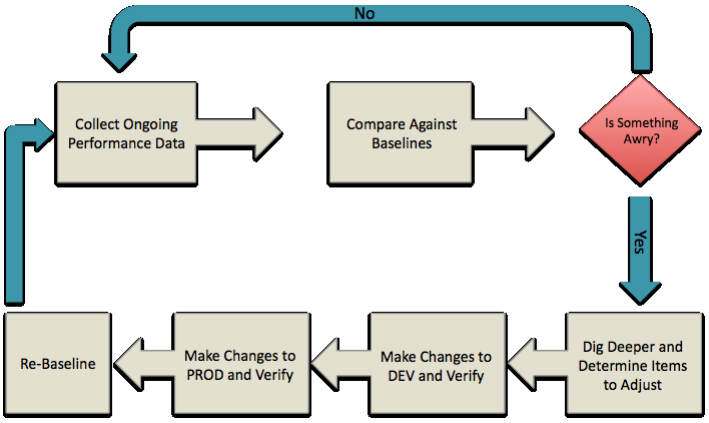
Uh Oh. Now What?

- Define the problem.
- Ask yourself what changed. When did it start?
- Examine current system state.
- Compare against your baselines.



Determine Your Issue's Scope

- Is everything running slow? Or is it just an individual query?
- Try to narrow down as far as you can go from a topical investigation
- If it is *everything*, put on your fire fighting hat and get started!
- Do not 'just start trying things'!

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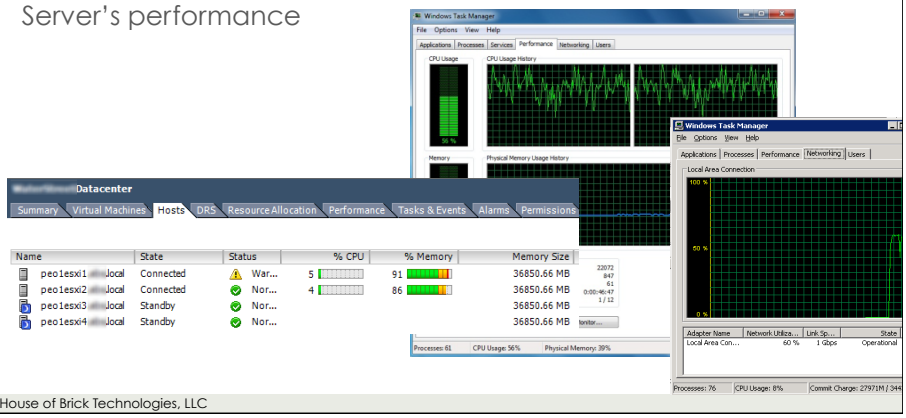
Is It Really SQL Server?

- Other things execute on that server other than sqlserver.exe
- Rule them out first. You'd be surprised what can run!
- Antivirus scans, system backups, application servers, network traffic, SAN contention, etc. – all can negatively impact your SQL Server's performance



Single Query

- Has it always run slow, or is it running slow now?
- Did someone load a lot of data recently?
- If just one query is running slow, check the execution plan of the query
  - Indexes and stats
  - Stuck execution plan
  - Pain points in the execution plan
  - Memory
- Does it run fast when connected locally but slow when executed remotely by the application?
  - Network performance? 'Client Processing'?
  - Situational!
    - (http://www.sommarskog.se/query-plan-mysteries.html)

Ask SQL Server What Hurts

- My performance triage method starts by quoting Paul Randal…
- "Where does it hurt?" Let's check the wait stats!
  - SQL Server Diagnostic Queries @ sqlserverperformance.wordpress.com – SQL Server 2012, April 2013

```
-- Isolate top waits for server instance since last restart or statistics clear  (Query 26) (Top Waits)
-- New SQL Server 2012-specific version
WITH Waits
AS (SELECT wait_type, CAST(wait_time_ms / 1000. AS DECIMAL(12, 2)) AS [wait_time_s],
CAST(100. * wait_time_ms / SUM(wait_time_ms) OVER () AS decimal(12,2)) AS [pct],
ROW_NUMBER() OVER (ORDER BY wait_time_ms DESC) AS rn
FROM sys.dm_os_wait_stats WITH (NOLOCK)
WHERE wait_type NOT IN (N'CLR_SEMAPHORE', N'LAZYWRITER_SLEEP', N'RESOURCE_QUEUE',N'SLEEP_TASK',
        N'SLEEP_SYSTEMTASK', N'SQLTRACE_BUFFER_FLUSH', N'WAITFOR', N'LOGMGR_QUEUE',
        N'CHECKPOINT_QUEUE', N'REQUEST_FOR_DEADLOCK_SEARCH', N'XE_TIMER_EVENT',
        N'BROKER_TO_FLUSH', N'BROKER_TASK_STOP', N'CLR_MANUAL_EVENT', N'CLR_AUTO_EVENT',
        N'DISPATCHER_QUEUE_SEMAPHORE' ,N'FT_IFTS_SCHEDULER_IDLE_WAIT', N'XE_DISPATCHER_WAIT',
        N'XE_DISPATCHER_JOIN', N'SQLTRACE_INCREMENTAL_FLUSH_SLEEP', N'ONDEMAND_TASK_QUEUE',
        N'BROKER_EVENTHANDLER', N'SLEEP_BPOOL_FLUSH', N'SLEEP_DBSTARTUP', N'DIRTY_PAGE_POLL',
        N'HADR_FILESTREAM_IOMGR_IOCOMPLETION',N'SP_SERVER_DIAGNOSTICS_SLEEP')),
Running_Waits
AS (SELECT W1.wait_type, wait_time_s, pct,
SUM(pct) OVER(ORDER BY pct DESC ROWS UNBOUNDED PRECEDING) AS [running_pct]
FROM Waits AS W1)
SELECT wait_type, wait_time_s, pct, running_pct
FROM Running_Waits
WHERE running_pct - pct <= 99
ORDER BY running_pct
OPTION (RECOMPILE);
```


So What Hurts?

- Ask SQL Server where it hurts, but do not jump to any conclusions just yet…
- Categories
  - CPU
  - Storage
  - Network
  - Locks
  - Other Stuff
- Let the wait stat data lead you to additional investigation

Results | Messages

	wait_type	wait_time_s	pct	running_pct
1	CXPACKET	1103.01	37.55	37.55
2	OLEDB	627.37	21.36	58.91
3	BACKUPIO	190.08	6.47	65.38
4	BACKUPTHREAD	154.76	5.27	70.65
5	ASYNC_IO_COMPLETION	133.31	4.54	75.19
6	BACKUPBUFFER	122.44	4.17	79.36
7	LCK_M_S	111.36	3.79	83.15
8	PREEMPTIVE_OS_FILEOPS	72.69	2.47	85.62
9	PAGEIOLATCH_SH	60.16	2.05	87.67
10	SOS_SCHEDULER_YIELD	53.23	1.81	89.48
11	MSQL_XP	47.55	1.62	91.10
12	IO_COMPLETION	35.25	1.20	92.30
13	CHKPT	22.92	0.78	93.08
14	SLEEP_MASTERDBREADY	22.88	0.78	93.86
15	WRITELOG	19.87	0.68	94.54
16	PREEMPTIVE_OS_LIBRARYOPS	19.67	0.67	95.21

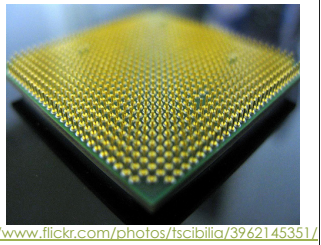
Reference: http://bit.ly/ZJ4usd
http://www.brentozar.com/sql/wait-stats/
http://bit.ly/15CUCYI

What Are The Waits?

- CPU
  - CX_PACKET
  - THREADPOOL
- Memory
  - PAGELATCH_XX
  - RESOURCE_SEMAPHORE
- Storage
  - PAGEIOLATCH_XX
  - WRITELOG
  - BACKUPIO
  - BACKUPBUFFER
  - IO_COMPLETION
  - SOS_SCHEDULER_YIELD
- Network
  - ASYNC_NETWORK_IO
- Locks and Latches
  - PAGEIOLATCH_XX
  - PAGELATCH_XX
  - LCK_M_XX
  - LATCH_XX
- Other Stuff
  - ONDEMAND_TASK_QUEUE
  - OLEDB
  - MSQL_XP

Symptom: CPU

- Obvious – code change that introduced bad code!
- High number of recompilations
- Query with high CPU consumption, or one with low CPU consumption but very high execution counts
- Inappropriate MaxDOP or Cost Threshold for Parallelism settings
- Out of date statistics
- Bad query execution plan
- Resource contention / blocked processes
- Anyone running a Profiler trace?
- Someone manually running ad-hoc queries?
- Windows CPU power plan set to balanced



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Symptom: Memory

- Max Server Memory set too low
- Low memory for the OS is causing excessive paging
  - Want GT 150MB free for OS to stop panickingLow Page Life Expectancy
  - 300 is not the magic number! http://bit.ly/11kv1O3
- Buffer pool pressure or outside
  - Linked Servers, CLR, etc.
- Buffer Cache hit ratio LT 90%
- DBCC MEMORYSTATUS
- Read More:
  - http://bit.ly/YnOgTM and http://bit.ly/X03Ghv

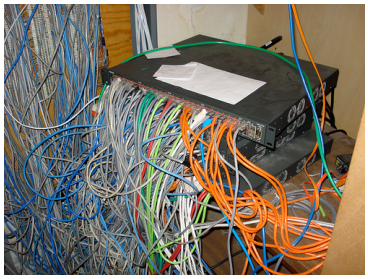
http://www.flickr.com/photos/teclasora/66268509/

Symptom: Storage

- RAID type, cache amounts, and interconnect speed
- Excessive disk stalls and latencies
- Correlated events
  - Lack of memory
  - Poorly constructed, unused, or missing indexes
- Background activity spike
  - Background from the server
  - Background on the same set of disks
  - Background on SAN controller
  - Background on interconnects
- Fragmentation / Fill Factor
- Database Design (GUIDs)

Symptom: Network

- Identify
  - Is it from within SQL Server
  - Bottlenecked by physical infrastructure
  - Abnormal problem elsewhere
- Usual cause: Application cannot process data as fast as SQL Server can send it
- Application design
  - Sending too much data for the app to filter quickly
  - Pagination techniques
  - SELECT * FROM…



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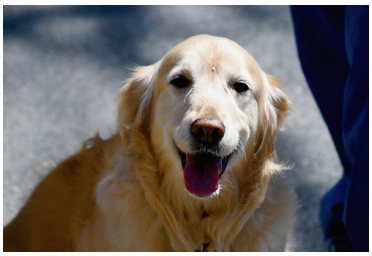
Symptom: Other

- Misuse of transactions, triggers, or cursors – locking/blocking
- Mixing OLTP, OLAP, and reporting workloads – locking/blocking
- Long running queries - everything
- TempDB contention – latch contention
- 'Noisy neighbor' conditions
- Virtualization – host contention
- *Only a billion other things that can go wrong!*

http://www.flickr.com/photos/infidelic/4306205887/

In Conclusion…

- Proactive
  - Understand SQL Server internals and troubleshooting techniques
  - Understanding your environment, workloads, and bottlenecks
  - Establishing your various workload baselines
  - Monitoring performance statistics to know when something is abnormal
- Reactive
  - Deep understanding of the workload(s) and its relation to the system stack so you can dive in quickly and perform root cause analysis
  - Effective (not trial and error) triage and remediation through cause (and not symptom) identification



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Questions

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