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SQL Saturday #721 – Raleigh 2018



Environmental SQL Server Troubleshooting

Who Am I?

DBA/Developer about 15 years

MS Information Science – University of Pittsburgh

Databases – Security – Privacy

Escalation Engineer – Tech Lead at Varonis



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Blog: www.MlakarTechTalk.com



Agenda – Troubleshooting

- Environmental?
- SQL Server
- Windows Server
- VMware





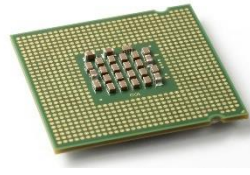
SQL Server Configurations

SQL Server Configurations

- SQL Server Configurations
 - Resource Allocation
 - CPU
 - Memory
 - Disk
 - Instance level configurations
 - Database level configurations



SQL Server - CPU



- MAXDOP
 - Max # of processors used for the execution of a query in a parallel plan
 - Determines computing and thread resources

A screenshot of the SQL Server Enterprise Manager interface. The left pane shows the 'Server Properties' dialog box with the 'Advanced' tab selected. The right pane displays the configuration for the 'Parallelism' category, which is highlighted with a red box. The configuration includes the following settings:

Property	Value
FILESTREAM Access Level	Disabled
FILESTREAM Share Name	MSSQLSERVER
Allow Triggers to Fire Others	True
Blocked Process Threshold	0
Cursor Threshold	-1
Default Full-Text Language	1033
Default Language	English
Full-Text Upgrade Option	Rebuild
Max Text Replication Size	65536
Optimize for Ad hoc Workloads	False
Scan for Startup Procs	True
Two Digit Year Cutoff	2049
Network Packet Size	4096
Remote Login Timeout	20
Cost Threshold for Parallelism	5
Locks	0
Max Degree of Parallelism	0
Query Wait	-1

There are exceptions but this is a good starting place:

<https://support.microsoft.com/en-us/kb/2806535>



SQL Server - CPU

- The default is 0 – i.e. use all cores
- For < 8 logical cores, assign the value to be the number of logical cores
- For ≥ 8 logical cores, assign the value to be 8
- Exceptions exist – good starting place
 - SharePoint, OLTP vs OLAP
 - Diminishing returns
- How do you know if there are MAXDOP problems?



SQL Server - CPU

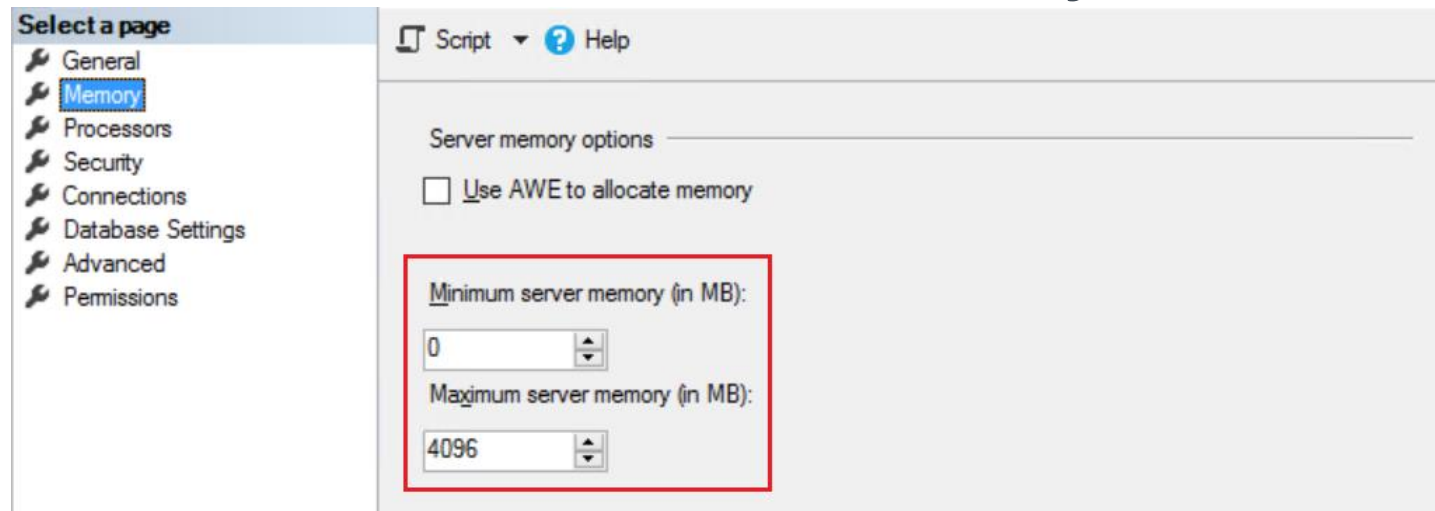
- Cost threshold for parallelism
 - Default is 5
 - Based on estimated query cost
 - Suggest 50
 - Legend of CTP
 - <https://sqlstudies.com/2017/04/17/what-is-the-cost-in-cost-threshold-for-parallelism/>
- Processor and I/O Affinity
 - Controls CPU processors that SQL Server will use
 - We typically want SQL to use all processors



SQL Server - Memory



- The default memory allocated to a SQL Instance is 0 for min server memory and 2147483647 for max server memory (i.e. all).
- Set the minimum server memory to 0



SQL Server - Memory

- Set the maximum server memory depending on what else is running on the machine
- Typically leave Windows Server \geq 4GB
- SSRS, SSIS, SSAS should have $!<$ 4GB each
- If other apps on machine add more memory
- Assign the rest to SQL Server



SQL Server - Memory

- Examples:

Total RAM = 16GB	
Component	Memory Allocated (GB)
OS	4
SSRS	4
App	4
SQL	4

Total RAM = 64GB	
Component	Memory Allocated (GB)
OS	4
SSRS	8
App	4
SQL	48

Total RAM = 128GB	
Component	Memory Allocated (GB)
OS	8
SSRS	8
App	4
SQL	108

<https://www.sqlskills.com/blogs/jonathan/how-much-memory-does-my-sql-server-actually-need/>



SQL Server - Memory

- CLR
 - Starting with SQL Server 2012, CLR allocations are also included in memory limits that are controlled by max server memory (MB) and min server memory (MB).
- Prior it was addressed in the OS memory space
 - <https://support.microsoft.com/en-us/kb/2663912>



SQL Server - Disk



- Separate DB files on different disks
 - Database files (system / user) – MDF, NDF
 - Transaction logs – LDF
 - Tempdb
 - Backups - BAK
 - Trace files – TRN
 - OS / SQL binaries / page file
- At a minimum - data and xact log files separate
- What do you put on the fastest disk?



SQL Server - Disk

- Disk Setup - example

Database Files	• mdf / ndf
Transaction Logs	• ldf
tempdb	• tempdb data and log
Backups	• bak / diff / trn
Traces	• trn
Page File	• pagefile.sys
OS	• Windows Files
SQL Server	• SQL Server Binaries



SQL Server – Instance Configuration

- Maximum worker threads
 - Default is 0 – leave it alone
 - [https://msdn.microsoft.com/en-us/library/ms190219\(v=sql.110\).aspx](https://msdn.microsoft.com/en-us/library/ms190219(v=sql.110).aspx)
 - I have seen both too limited and too much – rare scenarios

The screenshot shows the 'Server Properties' dialog box for a SQL Server instance, with the 'Processors' tab selected. The 'Threads' section is visible, showing 'Maximum worker threads' set to 0. A red arrow points to this value. Other options include 'Enable processors' (checked), 'Automatically set processor affinity mask for all processors' (checked), 'Automatically set I/O affinity mask for all processors' (checked), 'Boost SQL Server priority' (unchecked), and 'Use Windows fibers (lightweight pooling)' (unchecked). A table below shows processor affinity settings for 'ALL' processors.

Processor	Processor Affinity	I/O Affinity
+ ALL	<input type="checkbox"/>	<input type="checkbox"/>

<https://docs.microsoft.com/en-us/sql/database-engine/configure-windows/configure-the-max-worker-threads-server-configuration-option>



SQL Server – Instance Configuration

- Boost SQL priority
 - Default is unchecked – leave alone

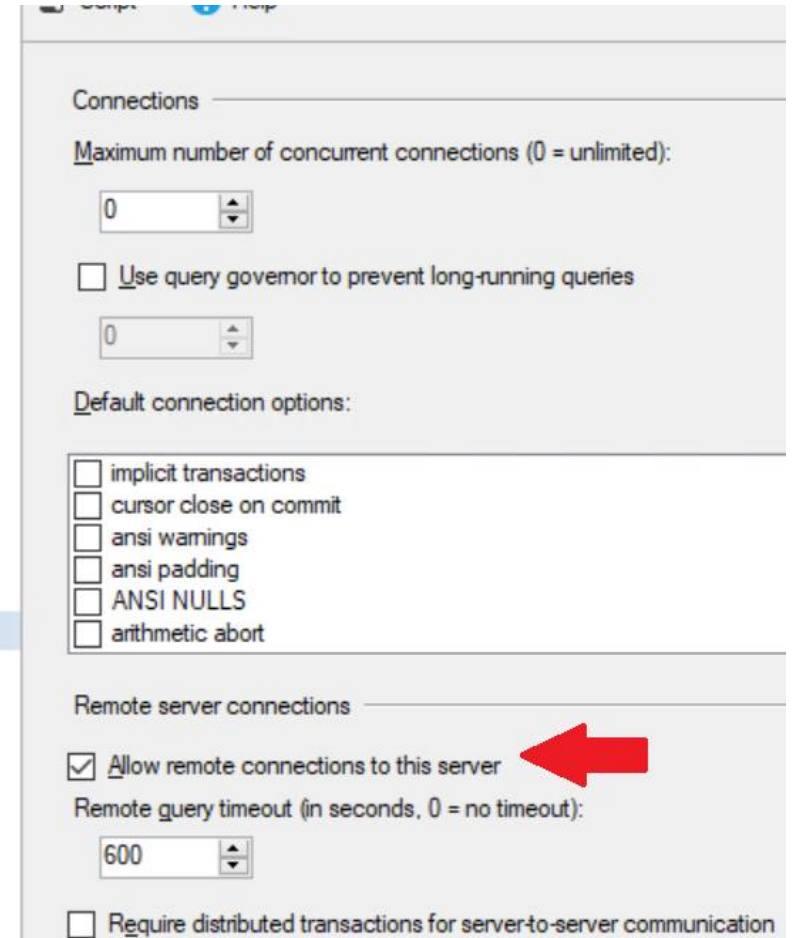
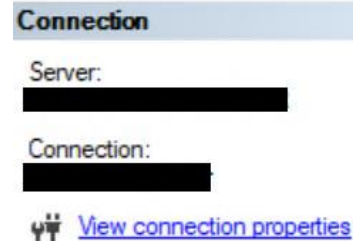
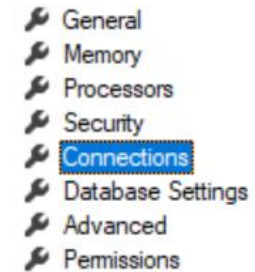


FWIW marked for deprecation
[https://technet.microsoft.com/en-us/library/ms180943\(v=sql.105\).aspx](https://technet.microsoft.com/en-us/library/ms180943(v=sql.105).aspx)



SQL Server – Instance Configuration

- Remote server connections
 - Default is checked – leave it alone
 - This is an obscure SQL Server to SQL Server communication feature.
 - It has been **deprecated** and should not be used.
 - It is often confused with remote access to the instance. However, that is not the case.



SQL Server – Instance Configuration

- Maximum # of concurrent connections
 - Default is 0 – leave it alone
- Remote query timeout
 - Default is 0 (no timeout) – leave it
- Query wait
 - Time in seconds that a query waits for resources before timing out
 - Default is -1 – leave it alone

Parallelism	
Cost Threshold for Parallelism	250
Locks	0
Max Degree of Parallelism	2
Query Wait	-1

Query Wait
Specify the time in seconds that a query waits for resources before timing out. If the default value of -1 is used, then the time-out is calculated as 25 times of the estimated query cost.

The screenshot shows the SQL Server Enterprise Manager configuration console. The left pane shows the tree view with 'Connections' selected. The right pane displays the configuration for the selected instance. Two red arrows point to the 'Maximum number of concurrent connections' and 'Remote query timeout' settings.

Connections

Maximum number of concurrent connections (0 = unlimited): 0

Use query governor to prevent long-running queries

Default connection options:

- implicit transactions
- cursor close on commit
- ansi warnings
- ansi padding
- ANSI NULLS
- arithmetic abort

Remote server connections

Allow remote connections to this server

Remote query timeout (in seconds, 0 = no timeout): 600

Require distributed transactions for server-to-server communication



SQL Server – Instance Configuration

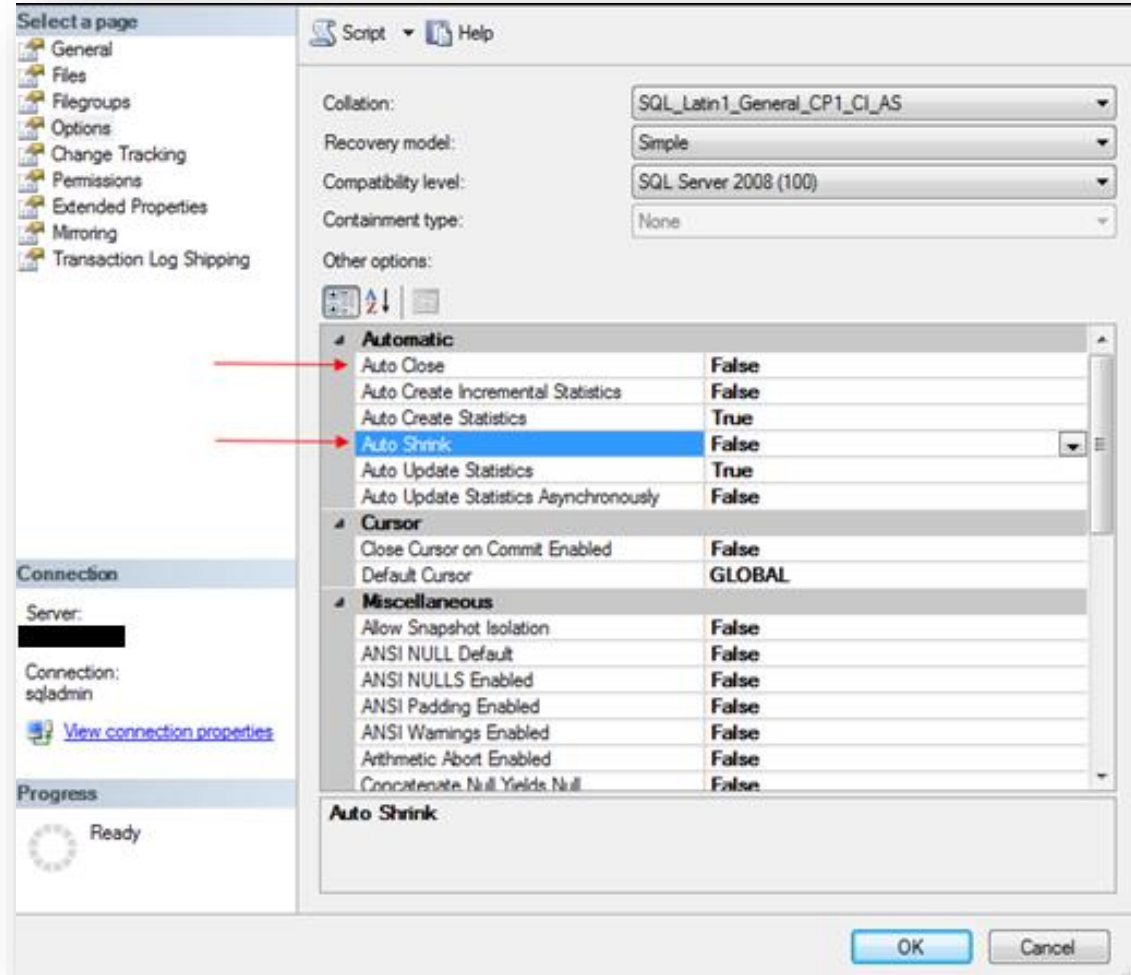
- TempDB
 - 1 file per logical core up to 8 then evaluate
 - Increase in sets of 4
 - Initial size should be the same for all
 - Autogrow in MB not %
 - Trying to reduce allocation contention
 - Trace Flags – default in SQL Server 2016
 - 1117
 - 1118

<https://support.microsoft.com/en-us/help/2154845/recommendations-to-reduce-allocation-contention-in-sql-server-tempdb-d>



SQL Server – Database Level Configurations

- Auto Close
- Auto Shrink

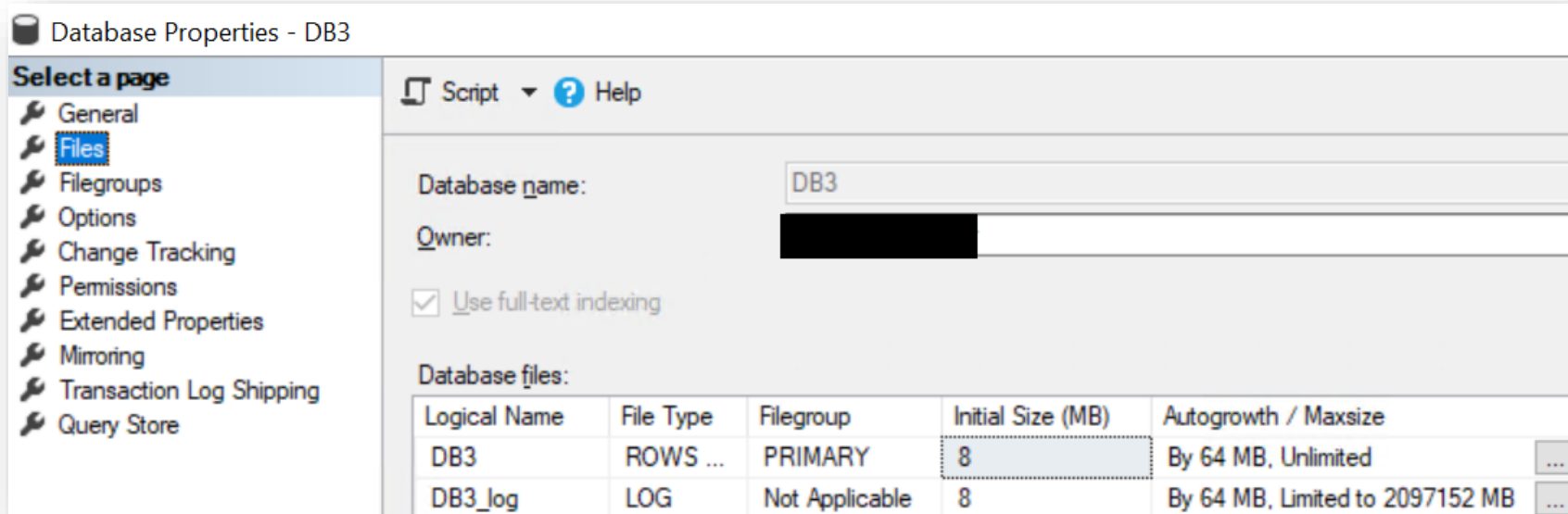


MS Best Practice: Considerations for the "autogrow" and "autoshrink" settings in SQL Server
Read this: <http://support.microsoft.com/kb/315512>



SQL Server – Database Configuration

- Database file defaults
 - Initial size
 - Autogrowth / Maxsize



The screenshot displays the 'Database Properties - DB3' window in SQL Server Enterprise Manager. The 'Files' tab is selected in the left-hand navigation pane. The main area shows the following configuration:

- Database name: DB3
- Owner: [Redacted]
- Use full-text indexing

The 'Database files' table is shown below:

Logical Name	File Type	Filegroup	Initial Size (MB)	Autogrowth / Maxsize
DB3	ROWS ...	PRIMARY	8	By 64 MB, Unlimited
DB3_log	LOG	Not Applicable	8	By 64 MB, Limited to 2097152 MB





Operating System Troubleshooting

Operating System

- Windows Server
 - General Configurations
 - Power Settings
 - AV
 - IFI
 - Page file
 - WSFC
 - Firewall
 - Scheduled Tasks
 - Disk Partition Alignment



Windows Server – General Configurations

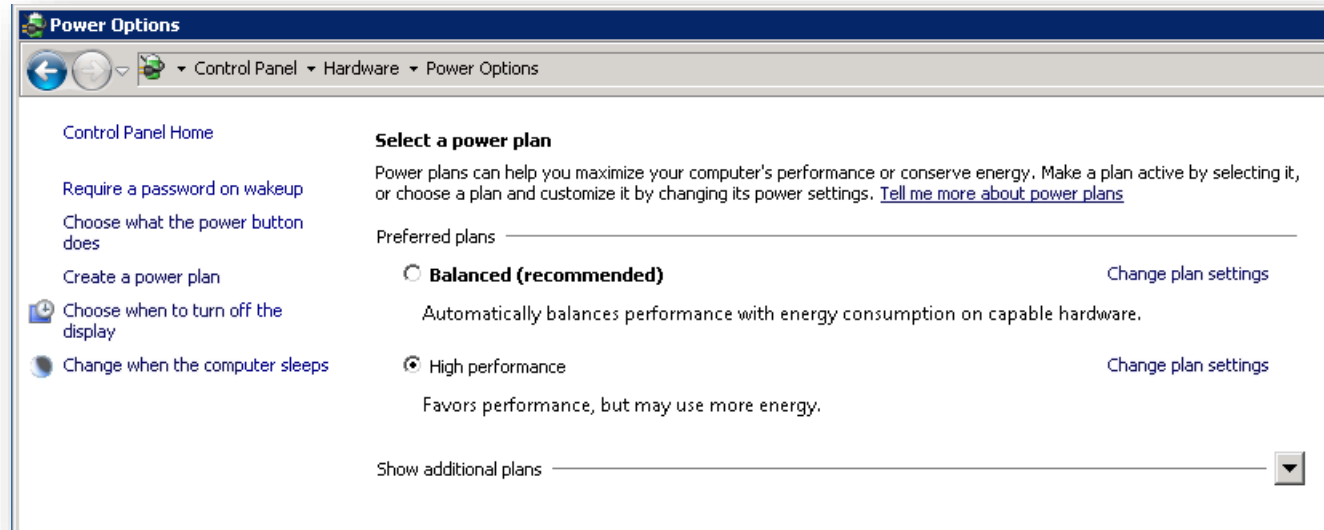
- Windows Update
 - Disable automatic updates
 - Otherwise there will be unmanaged downtime to the applications running on this machine
- Windows OS Roles
 - Only install and activate necessary roles
- Windows OS Features
 - Only install and activate necessary features
- What non-default software is running on a machine running a SQL Instance?



Windows Server - Power

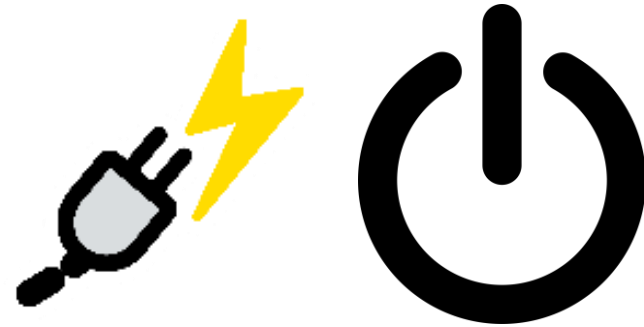


- Default power setting is “Balanced”.
 - This is **not** acceptable
 - Will throttle system resources globally to all applications and significantly hinder SQL performance
 - **ALWAYS** set to **HIGH** performance!



Windows Server - Power

- Power Setting Trickery
 - BIOS level power setting
 - HP ProLiant
 - Dell PowerEdge
 - Group Policy level power setting

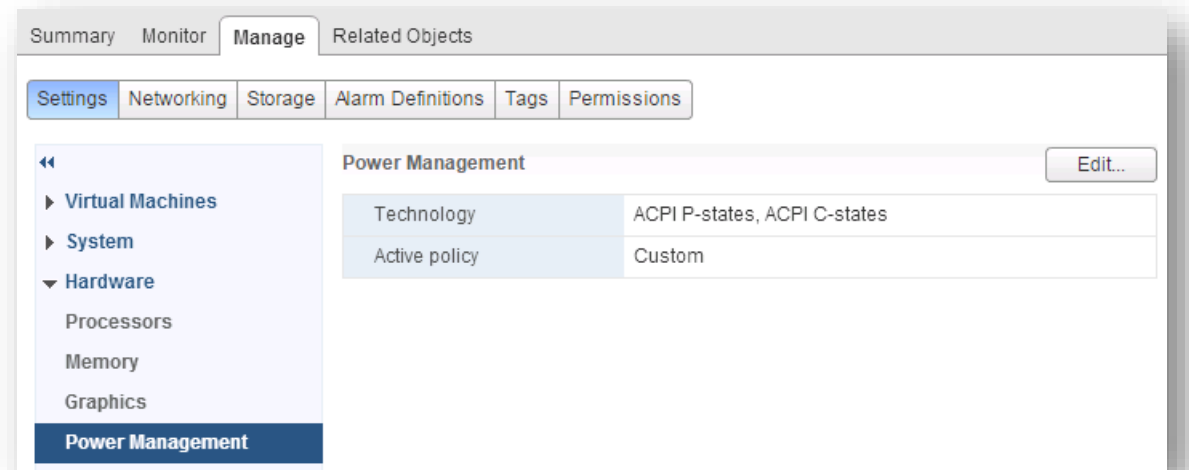
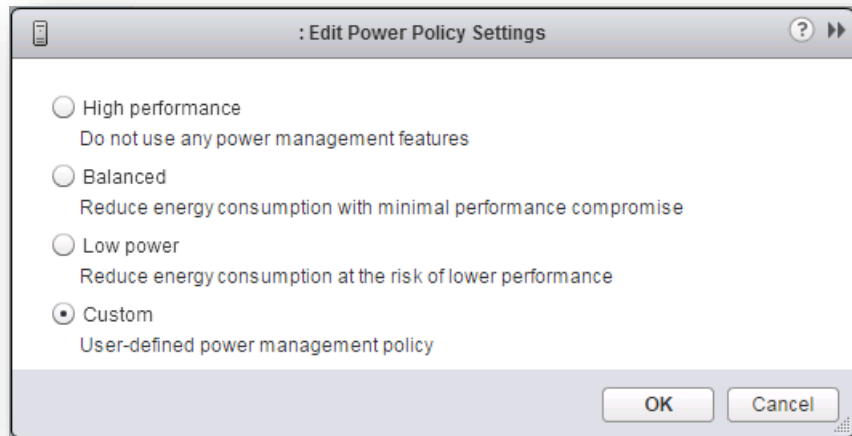


Setting	State	Comment
Button Settings		
Energy Saver Settings		
Hard Disk Settings		
Notification Settings		
Sleep Settings		
Video and Display Settings		
Specify a custom active power plan	Not configured	No
Select an active power plan	Not configured	No



Windows Server - Power

- Power Setting Trickery
 - vSphere power setting



<https://www.vmware.com/content/dam/digitalmarketing/vmware/en/pdf/techpaper/hpm-performance-vsphere55-white-paper.pdf>



Windows Server - AV

- Anti Virus – Exclusions
 - If AV is running on SQL host then whitelist DB files
 - MDF –file extensions associated with SQL Server database files
 - LDF – file extensions associated with SQL Server transaction log files
 - BAK – file extensions associated with SQL Server backup files
 - TRN – file extensions associated with SQL Server trace files
 - Directories and file name extensions to exclude from scanning
 - <https://docs.microsoft.com/en-us/sql/sql-server/install/file-locations-for-default-and-named-instances-of-sql-server>

<https://support.microsoft.com/en-us/help/309422/how-to-choose-antivirus-software-to-run-on-computers-that-are-running>



Windows Server - Instant File Initialization

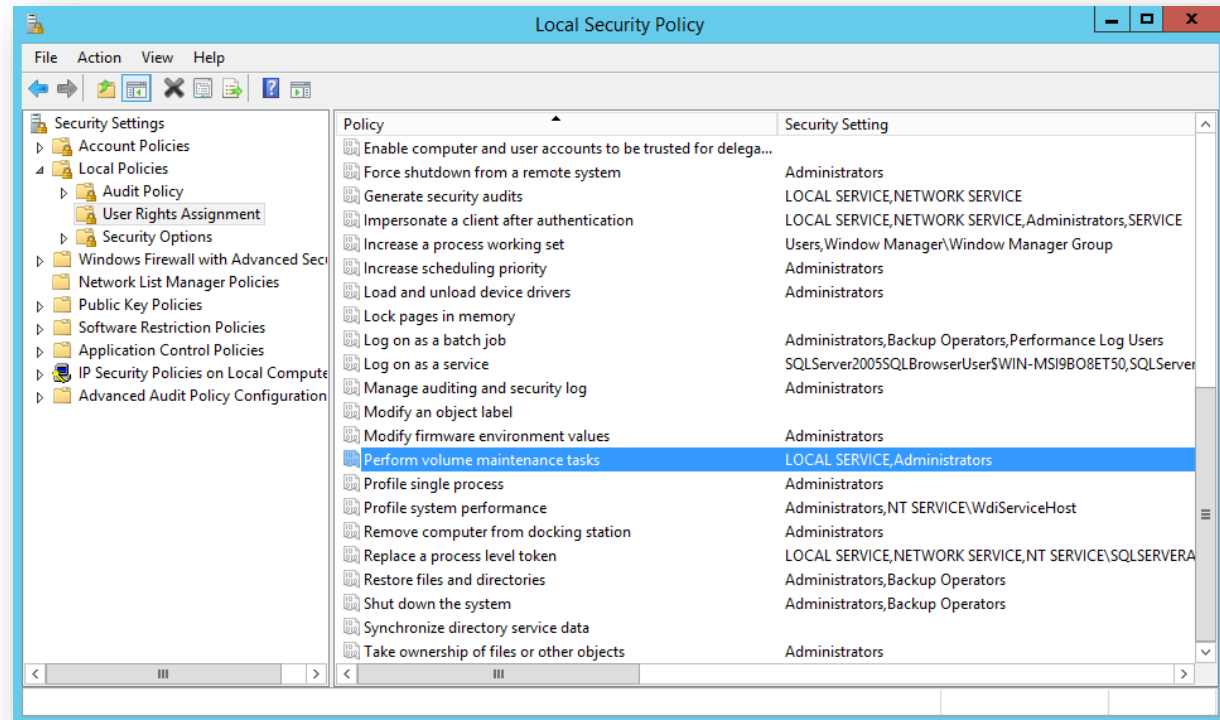
- File initialization
 - NTFS feature added to SQL Server 2005 for IFI using Windows Server 2003
 - Overwrite any existing data – fill with zeros
 - Create a database
 - Add data or log files to an existing database
 - Increase the size of an existing file (includes autogrowth)
 - Restore a database or filegroup
 - File won't be usable until it finishes zeroing out
 - SQL Error log after creating a DB post enabling IFI

```
2018-04-08 20:17:30.25 spid56 Zeroing C:\Program Files\Microsoft SQL Server\MSSQL13.MSSQLSERVER\MSSQL\DATA\IFI.mdf from page 0 to 1024 (0x0 to 0x800000)
2018-04-08 20:17:30.28 spid56 Zeroing completed on C:\Program Files\Microsoft SQL Server\MSSQL13.MSSQLSERVER\MSSQL\DATA\IFI.mdf (elapsed = 29 ms)
2018-04-08 20:17:30.30 spid56 Zeroing C:\Program Files\Microsoft SQL Server\MSSQL13.MSSQLSERVER\MSSQL\DATA\IFI_log.ldf from page 0 to 1024 (0x0 to 0x800000)
2018-04-08 20:17:30.34 spid56 Zeroing completed on C:\Program Files\Microsoft SQL Server\MSSQL13.MSSQLSERVER\MSSQL\DATA\IFI_log.ldf (elapsed = 38 ms)
2018-04-08 20:17:30.48 spid56 Starting up database 'IFI'.
2018-04-08 20:17:30.52 spid56 FixupLogTail(progress) zeroing C:\Program Files\Microsoft SQL Server\MSSQL13.MSSQLSERVER\MSSQL\DATA\IFI_log.ldf from 0x5000 to 0x6000.
2018-04-08 20:17:30.52 spid56 Zeroing C:\Program Files\Microsoft SQL Server\MSSQL13.MSSQLSERVER\MSSQL\DATA\IFI_log.ldf from page 3 to 249 (0x6000 to 0x1f2000)
2018-04-08 20:17:30.53 spid56 Zeroing completed on C:\Program Files\Microsoft SQL Server\MSSQL13.MSSQLSERVER\MSSQL\DATA\IFI_log.ldf (elapsed = 1 ms)
```



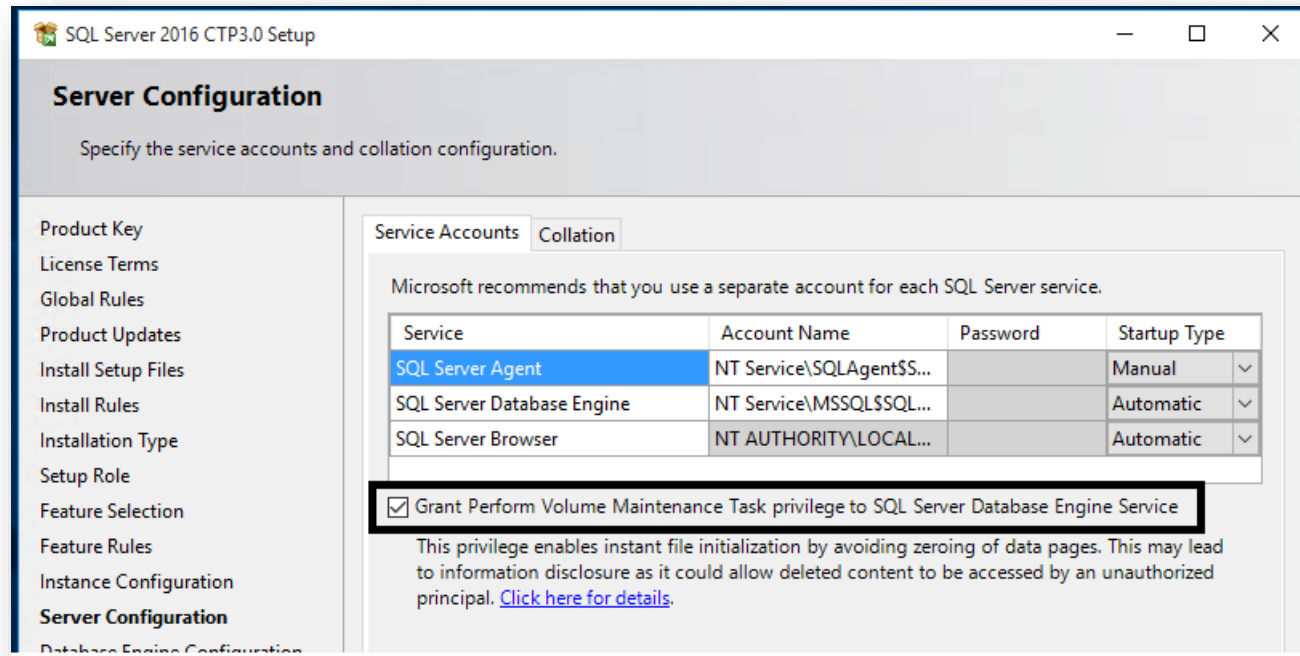
Windows Server – Instant File Initialization

- Local security policy
 - Local policies →
 - User rights assignment →
 - Perform volume maintenance tasks
- Add SQL Service account to enable IFI
- If changing the SQL Server service account then must restart service



Windows Server – Instant File Initialization

- SQL Server 2016 added IFI option during install



- Command line install option
 - `setup.exe /Q /ACTION="INSTALL" /IACCEPTSQLSERVERLICENSESETERMS /FEATURES="SQL" /INSTANCENAME="SQL2016" .. /SQLSVCINSTANTFILEINIT="True"`



Windows Server – Instant File Initialization

PROS

1. Improved performance during file initialization...significant

CONS

1. Security Consideration
 - a. Small possibility of disclosure of deleted content
 - b. Granting “Perform Volumes Maintenance Tasks” to a SQL Instance means you are giving admins of the instance the ability to read the encrypted contents of a recently deleted file
 - c. Mitigation
 - a. Always make sure any detached DBs and backup files have restrictive DACLs
 - b. Disable IFI for the instance
2. TDE

Overall – the PROS > CONS. Enable IFI as your default.



Windows Server – Page Files

- Page files are a special kind of file used as a temp workspace for storing modified pages from disk still in use by a process
- Holds data which is in the process of being swapped in and out of physical memory
- Allows a larger virtual memory set
- Large page files deserve their own disk (like data, xact log, tempdb, etc.)
- What does lots of page file usage mean?



Windows Server – Page Files

- PerfMon counters
 - **Memory: Committed Bytes** – number of bytes of virtual memory that has been committed
 - **Memory: Commit Limit** – number of bytes of virtual memory which can be committed without having to extend the paging files
 - **Paging File: % Usage** - % of the paging file committed
 - **Paging File: % Usage Peak** – highest % of the paging file committed



Windows Server – Page Files

- What is the Page File for anyway
 - <https://blogs.technet.microsoft.com/askperf/2007/12/14/what-is-the-page-file-for-anyway/>
- How to Determine the Appropriate Page File Size for 64-bit Versions of Windows
 - <https://support.microsoft.com/en-us/help/2860880/how-to-determine-the-appropriate-page-file-size-for-64-bit-versions-of>
- Page File – The Definitive Guide
 - <https://blogs.technet.microsoft.com/motiba/2015/10/15/page-file-the-definitive-guide/>



Windows Server - WSFC

- Windows Server Failover Cluster
 - If the WSFC feature is installed and running then make sure the best practices are being employed
 - Microsoft Windows Multi-Site Failover Cluster Best Practices (2012)
 - <https://blogs.technet.microsoft.com/meamcs/2013/11/09/microsoft-windows-multi-site-failover-cluster-best-practices/>
 - Windows Server 2008 R2 Failover Clustering – Best Practices Guide (2008 R2)
 - <https://blogs.technet.microsoft.com/aevalshah/2012/05/15/windows-server-2008-r2-failover-clustering-best-practice-guide/>



Windows Server - Firewall

- Windows Server Firewall
 - If running then make sure there are port exclusions for necessary ports for application to communicate

Port	Protocol	Usage
135	TCP	SSMS T-SQL Debugger
80	TCP	SSRS: http requests
443	TCP	SSRS: https requests SSL
1433	TCP	Default SQL Server port
1434	TCP	DAC
1434	UDP	SQL Server Browser

<https://docs.microsoft.com/en-us/sql/sql-server/install/configure-the-windows-firewall-to-allow-sql-server-access>



Windows Server – Scheduled Jobs

- Maintenance Jobs
 - SQL Server backups
 - SQL Server index maintenance
 - SQL Server dbcc checkdb
 - Disk space checks
- Make sure setup right and run off peak
- Monitor output and errors



Windows Server – Disk Partition Alignment

- Optimal disk configuration
 - Windows default is 1,024 kb cluster
 - Start at a more common sizing of 64 kb
 - Greater chance of playing nice with disks, controllers, and cache
 - Formatting disk to 64 kb cluster size can remediate suboptimal I/O performance

Disk Partition Alignment Best Practices for SQL Server

[https://technet.microsoft.com/en-us/library/dd758814\(v=sql.100\).aspx](https://technet.microsoft.com/en-us/library/dd758814(v=sql.100).aspx)





Virtualization

Virtualization

- VMware – accept no substitute
 - SQL Server on VMware best practices guide
- General Configurations
- CPU Ready
- Memory Ballooning
- Disk



VMware

- Troubleshooting Guidelines
 - Troubleshooting ESX/ESXi Virtual Machine Performance Issues
 - https://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=2001003
 - Tips for Configuring Microsoft SQL Server in a Virtual Environment
 - https://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=1002951



VMware

vSphere Key Performance Metrics

Table 9. Key Performance Metrics

Resource	Metric (resxtop)	Metric (vSphere Client)	Host/Virtual Machine	Description
CPU	%USED	Used	Both	CPU used over the collection interval (%).
	%RDY	Ready	Virtual Machine	CPU time spent in ready state.
	%SYS	System	Both	Percentage of time spent in the vSphere Server VMKernel.
Memory	Swapin, Swapout	Swapinrate, Swapoutrate	Both	Memory vSphere host swaps in/out from/to disk (per virtual machine, or cumulative over host).
	MCTLSZ (MB)	vmmemctl	Both	Amount of memory reclaimed from resource pool by way of ballooning.
Disk	READs/s, WRITEs/s	NumberRead, NumberWrite	Both	Reads and Writes issued in the collection interval.
	DAVG/cmd	deviceLatency	Both	Average latency (ms) of the device (LUN).
	KAVG/cmd	Kernellatency	Both	Average latency (ms) in the VMkernel, also known as queuing time.
	GAVG/cmd	TotalLatency	Both	Average latency (ms) in the guest. GAVG = DAVG + KAVG.
Network	MbRX/s, MbTX/s	Received, Transmitted	Both	Amount of data transmitted per second.
	PKTRX/s, PKTTX/s	PacketsRx, PacketsTx	Both	Packets transmitted per second.
	%DRPRX, %DRPTX	DroppedRx, DroppedTx	Both	Dropped packets per second.



VMware – CPU Ready

- Overcommitting the VM Host CPU to Guest VMs
 - Can cause more trouble than benefit.
 - Hypervisor must keep track of CPUs and context switch between them across all guest VMs.
 - Try to “Right-Size” the guest machines rather than over commit.
- ***Recommend a CPU Ready of under 5%.***
- The command “esxtop” can be run from the ESX host to get general statistics about the VM host.



VMware – CPU Ready

- Waits in CPU Ready below 10,000ms.
 - A range of 5000-8000ms should be as high as they get.
 - Reservations on CPU
- CPU Shares - High
- Converting Between CPU Summation and CPU % Ready Values
 - https://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=2002181
- Determining if Multiple Virtual CPUs are Causing Performance Issues
 - https://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=1005362

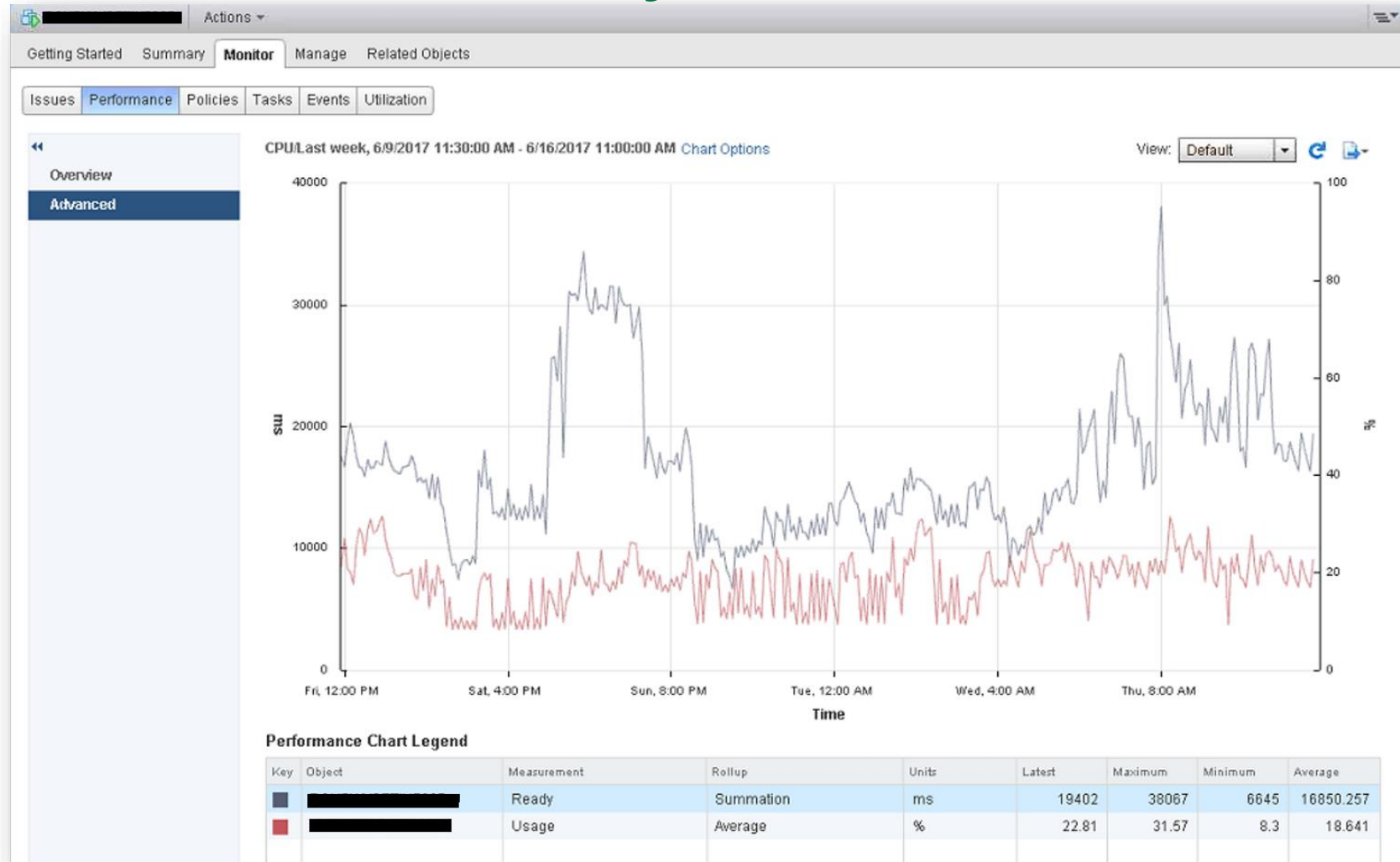


VMware – CPU Ready

- Examples of calculating CPU % Ready
 - Use the following formulas for the default chart update intervals
 - Realtime: CPU summation value / 200
 - Past Day: CPU summation value / 3000
 - Past Week: CPU summation value / 18000
 - Past Month: CPU summation value / 72000
 - Past Year: CPU summation value / 864000



VMware – CPU Ready



VMware – CPU Ready

- CPU Ready %
 - Min
 - $6645 / 18000 = 0.3692$
 - Average
 - $16850 / 18000 = 0.9361$
 - Max
 - $38067 / 18000 = 2.1148$



VMware – CPU Ready



https://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=2002181



VMware – Memory Ballooning

- Memory reservations
 - If in place make sure there is enough memory in the lower bound for the guest machine to perform without excessive paging.
 - Also make sure the VM host isn't stressed for memory and the hypervisor doesn't have to reclaim memory to service other guests.
- If memory is overcommitted then either increase memory to the host OR reduce memory to the guest VMs



VMware – Memory Ballooning

The screenshot shows the VMware vSphere Performance Monitor interface. The main chart displays CPU usage in MHz over time. A dialog box titled "Customize Performance Chart" is open, allowing configuration of the chart's data series. The "Balloon" counter is selected in the "Counters" list, and the "OK" button is highlighted with a red circle.

Customize Performance Chart

Saved Chart Settings: Default Always load these settings at startup

Chart Options

- CPU
 - Real-time
 - Past day
 - Past week
 - Past month
 - Past year
 - Custom...
- Datastore
- Disk
- Memory
 - Real-time
 - Past day
 - Past week
 - Past month
 - Past year
 - Custom...
- Network
- Power
- System
- Virtual disk

Chart Type

Line graph Stacked graph

Objects

Description: [Redacted]

All None

Counters

Description	Rollup	Units	Internal Name
<input type="checkbox"/> Memory saved by zipping	Latest	Kilobytes	zipSaved
<input type="checkbox"/> Decompression rate	Average	KBps	decompression
<input type="checkbox"/> Swapped	Average	Kilobytes	swapped
<input type="checkbox"/> Overhead touched	Average	Kilobytes	overheadTouc
<input checked="" type="checkbox"/> Balloon	Average	Kilobytes	vmmemctl

All None

Counter Description

Rollup: Average **Statistics Type:** Absolute

Amount of memory allocated by the virtual machine memory control driver (vmmemctl), which is installed with VMware Tools

Last: 1 Hour(s)

From: 8/27/2014 3:01 PM

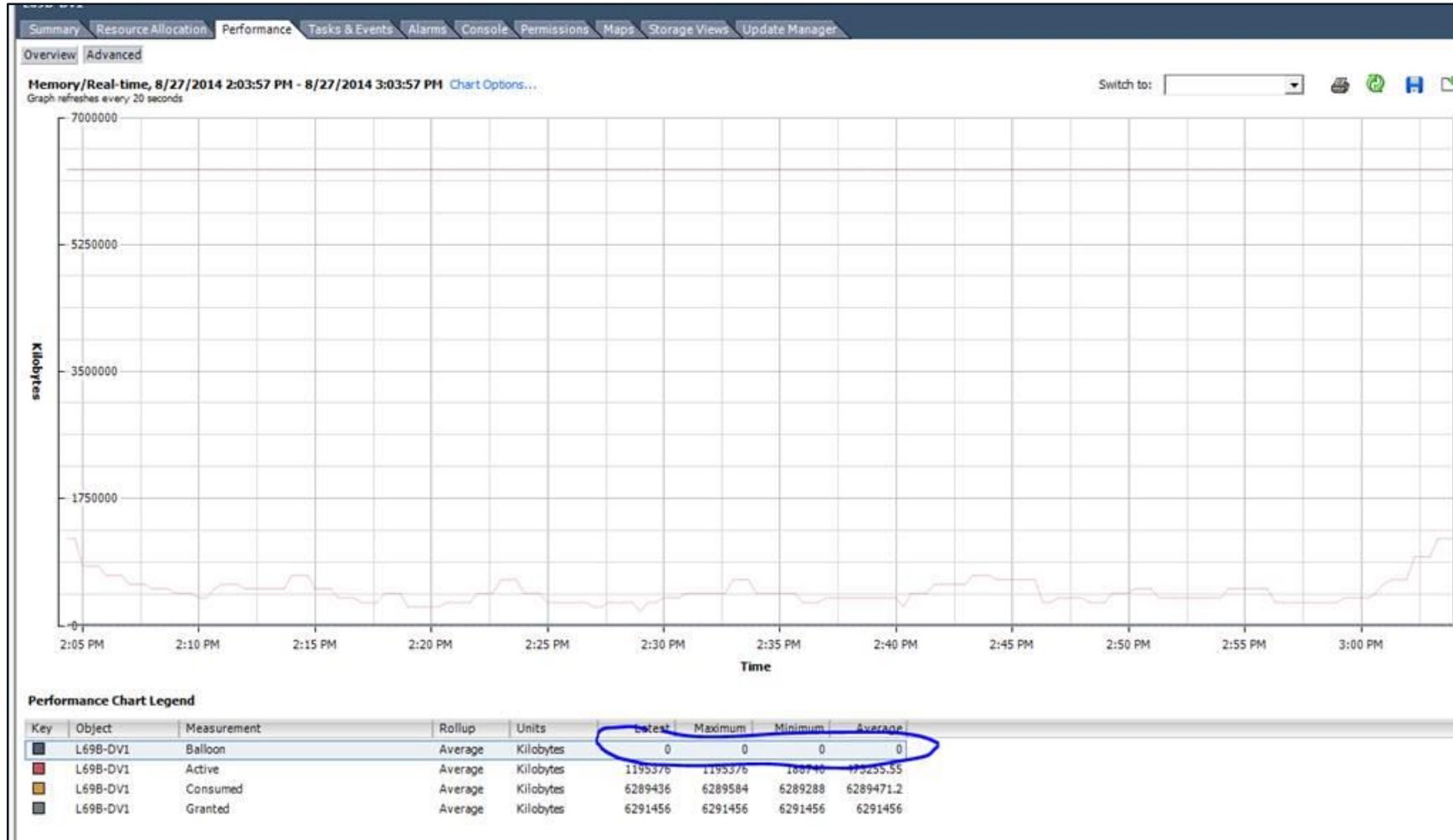
To: 8/27/2014 3:01 PM

Manage Chart Settings... Save Chart Settings...

Help OK Cancel Apply

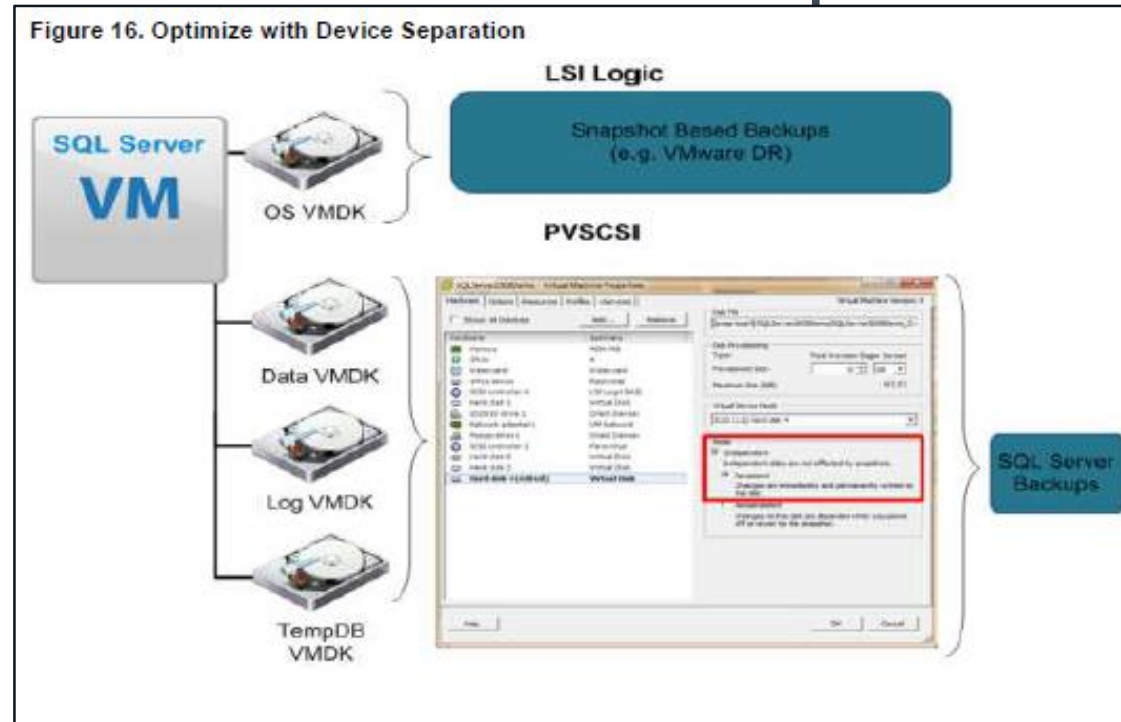


VMware – Memory Ballooning



VMware - Disk

- PVSCSI – Paravirtual SCSI adapter



[Configuring Disks to Use VMware Paravirtual SCSI \(PVSCSI\) Adapters](https://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=1010398)

https://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=1010398





Summary

Conclusions

- Defaults are often poor!
- Use best practices to configure SQL Server to minimize performance issues
 - Test, test, test!
- Know when to step outside the guidelines
 - Learn the exceptions



Thank You!

Q&A

@jmlakar



<https://www.linkedin.com/in/jeffmlakar/> **LinkedIn**

www.MlakarTechTalk.com