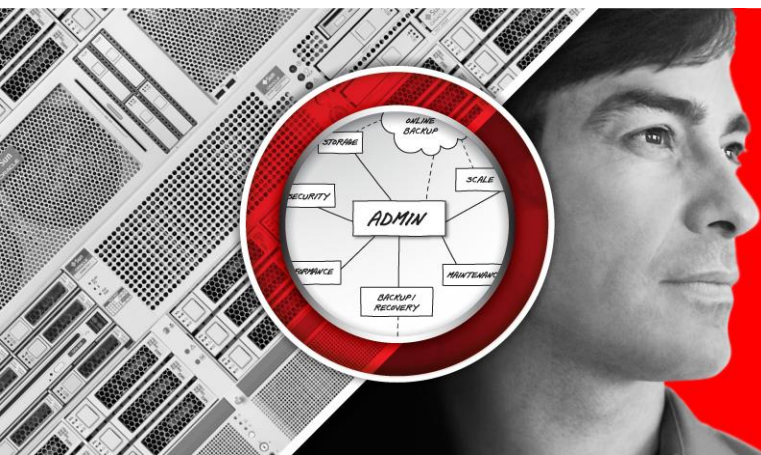


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## **Best Practices for Oracle Database Performance on Windows**

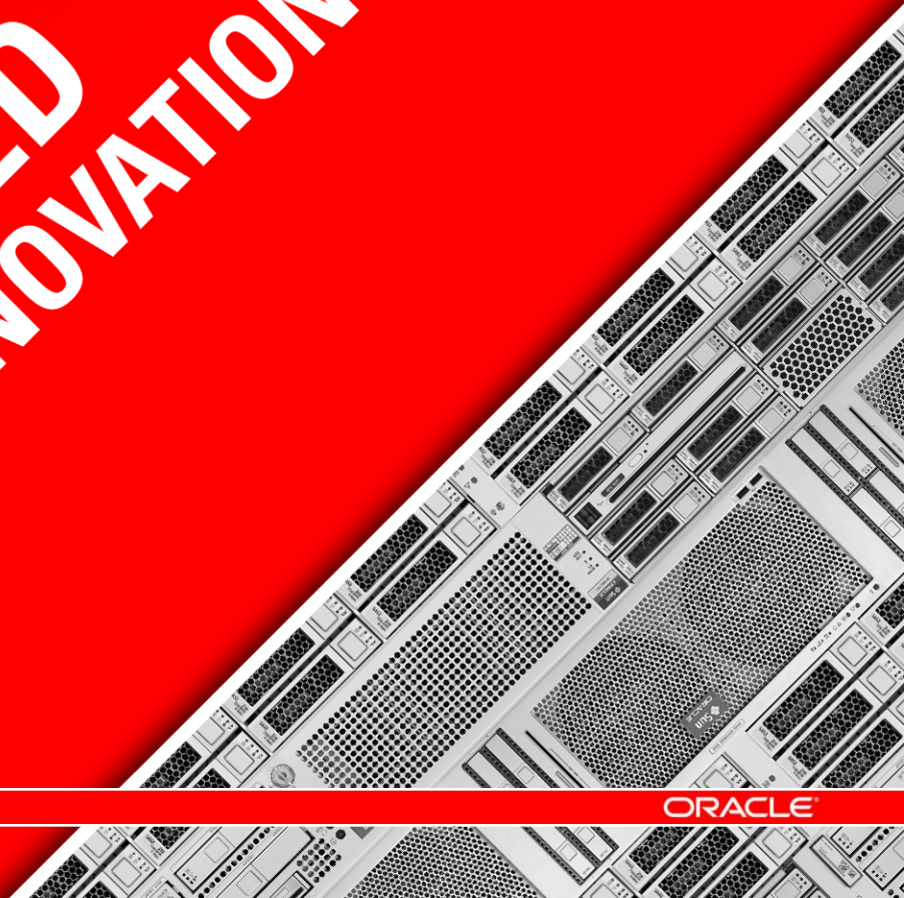
Christian Shay

Principal Product Manager, Oracle

The following is intended to outline our general product direction. It is intended for information purposes only, and may not be incorporated into any contract. It is not a commitment to deliver any material, code, or functionality, and should not be relied upon in making purchasing decisions. The development, release, and timing of any features or functionality described for Oracle's products remains at the sole discretion of Oracle.



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# Program Agenda

- Overview
- Architecture
- Best Practices for Windows (32 bit & 64 bit)
  - Windows OS Diagnostic Tools
  - Optimize CPU usage, Optimize Network, Optimize File I/O
- Best Practices for 32 bit Windows
- Best Practices for 64 bit Windows
- Q+A: Ask the Experts



# Windows 32-bit Platform Support

OS	10gR2	11gR1	11gR2
Windows XP Professional	Yes	Yes	Yes
Windows Server 2003 and Windows Server 2003 R2	Yes	Yes	Yes *
Windows Vista	10.2.0.4	Yes	Yes
Windows 7	10.2.0.5	No	Yes
Windows Server 2008	10.2.0.4	11.1.0.7	Yes

\* - RAC not supported for 32-bit Windows in 11gR2

# Windows 64-bit Platform Support

OS	10gR2	11gR1	11gR2
Windows XP, Windows Server 2003, and Windows Server 2003 R2, x64 Editions	Yes	Yes	Yes
Windows Vista for x64 systems	10.2.0.4	Yes	Yes
Windows 7 for x64 systems	10.2.0.5	No	Yes
Windows Server 2008 for x64 systems	10.2.0.4	11.1.0.7	Yes
Windows Server 2008 R2 for x64 systems	10.2.0.5	No	Yes
Windows Server 2003 for Itanium	Yes	No	No
Windows Server 2008 for Itanium	10.2.0.5	No	No

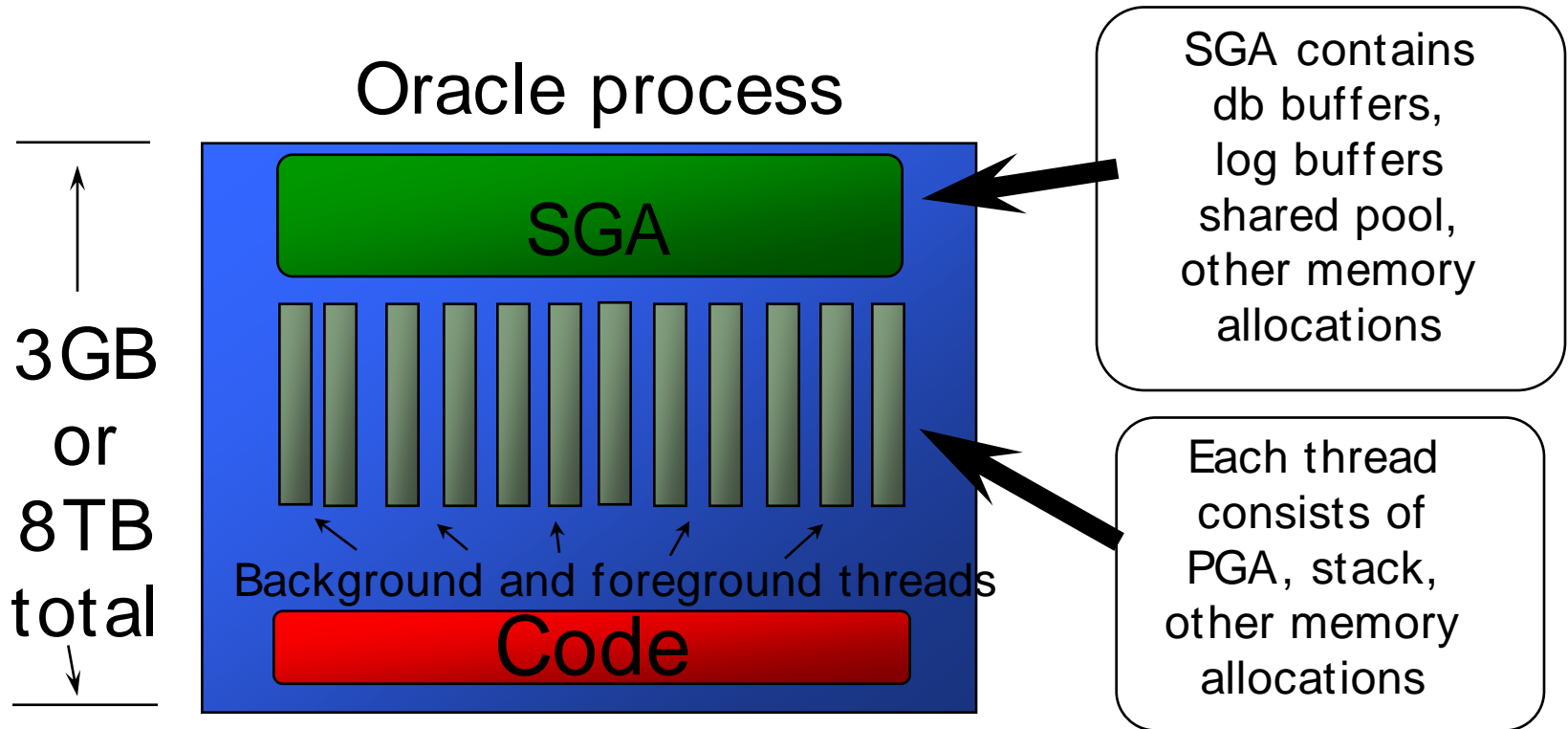
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# Architecture: Thread Model



# Database Architecture

- Thread model, not a straight port of Oracle's process architecture
- 3GB (32-bit) or 8TB (64-bit) maximum memory per database instance. VLM support allows >3GB on 32-bit.
- Runs as a Windows service process
- No limits on memory, connections, resources except those imposed by the operating system

# File I/O

- Oracle11g supports asynchronous I/O to all types of files
- Logical and physical raw files and partitions are fully supported (faster than NTFS)

# File I/O

- Full 64-bit file I/O internally (for both Win32 and Win64 OS). This means:
  - No 2GB or 4GB limitations on database file sizes.
  - Maximum file size is 64GB
  - Maximum database size is 4 petabytes

# File I/O

- Asynch IO support on Windows is very good for both file system and raw devices.
- No need to set INIT.ORA parameter “filesystemio\_options”
- Default value of “asynch” is the recommended setting.

# Windows Server 2003/2008

- Large Page support
  - For instances with large memory requirements, large page support can improve performance.
    - To enable, set registry parameter ORA\_LPENABLE to 1
    - 32 bit – 4kb default page size– will now be 2MB
    - 64 bit – 8kb default page size– will now be 16 MB
    - x64 – 8kb default page size – will now be 2 MB
  - Windows Server 2003 64-bit may be slow to allocate a huge amount of memory when using large pages especially if memory is already fragmented. Start Oracle before other processes if this affects you. This problem is reduced in Windows Server 2008.

# Windows Server 2003/2008

- NUMA support for memory/scheduling
  - Database intelligently allocates memory and schedules threads based on node configuration
  - Best Practices: For NUMA on AMD patch to a minimum 10.2.0.2 P5
- Test well before going into production, Work with your hardware vendor and Oracle support to enable NUMA.

# Hyperthreading

- Circuitry added to Intel CPUs resulting in single CPU functioning as 2 CPUs
- All versions of Oracle are supported in Hyperthreaded environments.



# Additional Integration with Windows

- Integration with Performance Monitor
- Integration with Event Log

# Direct NFS Client on Windows

- Network Attached Storage (NAS) uses Network File System (NFS)
- Oracle Database 11g allows direct Windows NFS v3 access
  - Part of DB kernel in Oracle Disk Manager library

# Direct NFS Client on Windows

- Specially useful for Windows as Kernel NFS is not natively supported on Windows
- Bypasses a lot of software layers in OS
- Tailored for the specific I/O patterns that Oracle uses

# Direct NFS

- Linear scalability of direct NFS can be achieved with inexpensive NICs - and
  - Does not require expensive switches which support link aggregation...Oracle does load balancing rather relying on a switch.
  - Parallel network paths – More NICs – more bandwidth
- Direct NFS is a good solution from low to high end database servers

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# Diagnostic Tools - Performance Monitor

The screenshot shows the Windows Performance Monitor application. The 'Add Counters' dialog box is open, allowing the user to select performance counters. The 'Performance object' is set to 'Process', and 'Virtual Bytes' is selected from the list of counters. The 'Instance' list shows 'oracle' selected. The background shows a graph with a vertical red line at approximately 47% and a table with columns for Color, Scale, Counter, and Instance.

Color	Scale	Counter	Instance
—	0.000...	Virtual By...	oracle

# Process Explorer

Process	PID	CPU	Description	Company Name	Path
WinMgmt.exe	1016		Windows Management Instrumentation	Microsoft Corporation	C:\WINNT\system32\wbem\WinMgmt.exe
nutsv4.exe	1092		NuTcracker Service	DataFocus, Inc.	C:\WINNT\system32\nutsv4.exe
telnetd.exe	1212		telnetd service	DataFocus, Inc.	C:\WINNT\system32\telnetd.exe
svchost.exe	1304		Generic Host Process for Win32 Services	Microsoft Corporation	C:\WINNT\system32\svchost.exe
cvprnd.exe	1412		Cisco Systems VPN Client	Cisco Systems, Inc.	C:\Program Files\Cisco Systems\VPN Client\cvprnd.exe
<b>ORACLE.EXE</b>	<b>2356</b>	<b>0.96</b>	<b>Oracle RDBMS Kernel Executable</b>	<b>Oracle Corporation</b>	<b>d:\oracle\ora92\bin\oracle.exe</b>
lsass.exe	264		LSA Executable and Server DLL (Expor...	Microsoft Corporation	C:\WINNT\system32\LSASS.EXE
Explorer.EXE	1252		Windows Explorer	Microsoft Corporation	C:\WINNT\explorer.exe
twatdog.exe	932				C:\WINNT\system32\WatDog.exe
ITouch.exe	1632		iTouch Application	Logitech Inc.	C:\Program Files\Logitech\iTouch\iTouch.exe
iclient.exe	1648	1.92	Integrity Client	Zone Labs Inc.	C:\Program Files\Zone Labs\Integrity Client\iclient.exe
qttask.exe	1664			Apple Computer, Inc.	C:\Program Files\QuickTime\qttask.exe
ccApp.exe	996		Symantec User Session	Symantec Corporation	C:\Program Files\Common Files\Symantec Shared\ccApp.exe
VPTray.exe	1240		Symantec AntiVirus	Symantec Corporation	C:\Program Files\Symantec AntiVirus\VPTray.exe
jusched.exe	1716		Java(TM) 2 Platform Standard Edition bi...	Sun Microsystems, Inc.	C:\Program Files\Java\jre1.5.0_04\bin\jusched.exe
ctfmon.exe	1732		Cicero Loader	Microsoft Corporation	C:\WINNT\system32\CTFMON.EXE
HotSync.exe	848		HotSync® Manager Application	PalmSource, Inc	C:\Program Files\Handspring\HotSync.exe
DvzIncMsgr.exe	1836		DataViz Update Checker	DataViz, Inc.	C:\Program Files\Common Files\DataViz\DvzIncMsgr.exe
trillian.exe	512		Trillian	Cerulean Studios	C:\Program Files\Trillian\trillian.exe
thunderbird.exe	1764		Mozilla Thunderbird	Mozilla.org	C:\Program Files\Mozilla Thunderbird\thunderbird.exe
firefox.exe	1064		Firefox	Mozilla	C:\Program Files\Mozilla Firefox\firefox.exe
Palm.exe	1024		Palm Desktop Application	PalmSource, Inc.	C:\Program Files\Handspring\Palm.exe
Communicator.exe	556		Cisco IP Communicator	Cisco Systems, Inc.	C:\Program Files\Cisco Systems\Cisco IP Communicator\Communicator.exe
POWERPNT.EXE	1696		Microsoft Office PowerPoint	Microsoft Corporation	C:\Program Files\Microsoft Office\OFFICE11\POWERPNT.EXE

Type	Name
Directory	\KnownDlls
Directory	\Windows
Directory	\BaseNamedObjects
Event	\BaseNamedObjects\userenv: User Profile setup event
Event	\BaseNamedObjects\crypt32.LogoffEvent
File	D:\oracle\oradata\vr92\UNDOTBS01.DBF
File	\Device\Tcp
File	\Device\Tcp
File	\Device\Tcp
File	\Device\Np
File	\Device\Np
File	\Device\Np
File	\Device\NamedPipe\EVENTLOG
File	\Device\Tcp
File	D:\oracle\oradata\vr92\ODM01.DBF
File	D:\oracle\oradata\vr92\SYSTEM01.DBF
File	D:\oracle\ora92\rdbms\msg\oraus.msb
File	D:\oracle\ora92\rdbms\msg\oraus.msb
File	D:\oracle\ora92\rdbms\msg\oraus.msb
File	D:\oracle\ora92\rdbms\msg\oraus.msb
File	D:\oracle\ora92\rdbms\msg\oraus.msb

CPU Usage: 6.73% | Commit Charge: 32.65% | Processes: 51

# OS Tools

- tasklist, taskkill
- tlist (Shows command line args with -c)
- driverquery
- diskpart
- sc (sc query state= all)
- regmon, filemon, procexp, tcpview
- Windows Services for Unix



# ODP.NET Integration with Performance Monitor

- Monitor Connection Pools (New Feature of ODP.NET 11.1)
- Enable in  
HKEY\_LOCAL\_MACHINE\SOFTWARE\ORACLE\ODP.NET\Assembly\_Version\PerformanceCounters

# ODP.NET Integration with Performance Monitor

Counters include (among many):

- HardConnectsPerSecond
- HardDisconnectsPerSecond
- SoftConnectsPerSecond
- SoftDisconnectsPerSecond
- NumberOfActiveConnection
- NumberOfFreeConnections

# Client Diagnosability on 11g

- Integrated with ADR
- OCI and Net tracing and logging uses ADR by default
- Multithreaded client-side diagnosability context support

# Client Diagnosability on 11g

- First Failure Capture
  - No need to reproduce a second time to get a dump
- Client and Server trace file correlation
- Reduce one-off diagnostic patches
- Structure Dump Facility
  - Dumps more than just a stack

# Client Characteristics

- V\$SESSION\_CONNECT\_INFO/GV\$SESSION\_CONNECT\_INF
  - CLIENT\_CHARSET (NLS character set)
  - CLIENT\_CONNECTION (Homogeneous/heterogeneous)
  - CLIENT\_OCI\_LIBRARY (Home-based, Instant Client Full/Light)
  - CLIENT\_VERSION (client RSF version)
  - CLIENT\_DRIVER (OCI/JDBC/other)
- OCI\_ATTR\_DRIVER\_NAME to set third party driver

# Client-Side Crash Handler

- Goal: handle segfaults, other core dumps
- As of 10.2, handler only in RDBMS server
- With 11g, we add one on client side
- Generates error message & stack trace, and controls core dump location

# CPU Tuning

- Oracle uses all processors available through the OS
- ORACLE\_AFFINITY registry value can be set to tell Oracle which threads to run on which processors (same setting for all instances)

# CPU Tuning

- Use Database Resource Manager to set CPU usage for different classes of users
  - For example, one can configure the db to use 50% CPU for gold customers, 30% for silver and 20% for rest
- Thread priorities can be set in the registry using the ORACLE\_PRIORITY variable



# CPU Tuning – Diagnosing High CPU

- Process Explorer: drill down to threads
- Get thread id of high CPU thread and then do query
- `SELECT a.spid, b.username FROM v$process a, v$session b WHERE a.addr= b.paddr AND a.spid = <thread number>`

# Networking Best Practices

- Use one listener per system
- The default queue-size for Windows Server is 50 – increase to 200 or 300 using QUEUESIZE parameter in LISTENER.ORA – prevents errors during login storms
- Listener Logon Storm Handler
  - Configurable on server side in LISTENER.ORA (RATE\_LIMIT = <max conn/sec>)
  - Use only if you have logon storm issues

# Networking Best Practices

- Increase “DEFAULT\_SDU\_SIZE” in SQLNET.ORA or “SDU” in TNSNAMES.ORA
  - Controls SQL\*Net packet size (Session Data Unit)
  - Default SDU size in 11g is now 8k. For bulk data transfer scenarios, increase DEFAULT\_SDU\_SIZE in sqlnet.ora or SDU in tnsnames.ora. It can be increased up to 32k (now 64K as of 11.2.0.2).

# Networking Best Practices

- Any mix of 11g and 10g will cause it to negotiate down to lower of the two peers (pre-11g default is 2K)
  - For 10g increase DEFAULT\_SDU\_SIZE to 8k or higher.
- Common misperception: Do not set to match MTU!

# Networking Best Practices: Shared Server vs. Dedicated Server

- Dedicated server gives very best performance
  - Each client connection has it's own thread
  - Memory usage is 2-4 MB per server thread
  - Oracle uses dedicated server for OLTP benchmarks
  - Can hit scalability limits due to memory use
- Shared server saves a lot of memory!
  - Idle connections will not consume much memory
  - Latency because dispatcher hands request to shared server
  - Good for large number of connections with many idle

# Networking Best Practices: Shared Server vs. Dedicated Server

- Recommendation: Use dedicated server if you have enough physical memory, otherwise use shared for all sessions that may be idle for some time.
- Continue to use dedicated server for a small number of high performance connections/queries.

# Networking Best Practices: Using Shared Server

- Client connections share pre-spawned server threads
  - No dedicated idle threads wasting resources
- Enable Shared Server on client in tnsnames.ora:  
(DESCRIPTION=  
  (ADDRESS=(PROTOCOL=tcp)  
    (HOST=sales-server)(PORT=1521))  
  (CONNECT\_DATA= (SERVICE\_NAME=sales.us.acme.com)  
    (**SERVER=shared**) ) )

# Networking Best Practices: Using Shared Server

- Modify init.ora parameters on server to enable shared servers
- Rough guidelines: 20 or 30 Shared Servers per 500 sessions, then tune from there
- Use 1 dispatcher for every 50-100 sessions
- See Net Admin Guide for more details



# Networking Best Practices: Oracle Database Resident Connection Pool

- Pools Oracle Dedicated Servers
- Shares server side connection pool across mid tier systems and processes
- Co-exists in all server configurations
  - Dedicated Servers, Shared Servers, RAC
- Most useful when you have many thousands of client processes connecting to a database server and each process needs to hold on to the database server session for a short time

# Networking Best Practices: Oracle Database Resident Connection Pool

- In test environment, we were able to support more than 20,000 connections to a 2 GB Database Server
- Pooling is optionally enabled by DBA on Server
- Client connect string also needs to have (SERVER=POOLED)

# Networking Best Practices: Connection Timeouts

- Client Side connection timeouts: Achieve fast failover when you have multiple addresses in connect string
  - TCP.CONNECT\_TIMEOUT – 11g feature – Constrains time required to go from client to database. It can be a few seconds. (60 Seconds default in 11.2). Tune down from there. Too low – false positives
  - SQLNET.OUTBOUND\_CONNECT\_TIMEOUT – Constrains only time required to go from client to listener (no db processing) - from 10gR2 and later – Not set by default.
  - These two timeouts can be used individually or at the same time

# Networking Best Practices: Connection Timeouts

- Server Side connection timeouts:
  - `SQLNET.INBOUND_CONNECT_TIMEOUT` – available in 10gR1 and later - default 60 secs for 10gR2 and 11g, not enabled by default for 10gR1; this can also be used along with the client side timeouts mentioned on the last slide.

# Networking Best Practices: TCP Optimization on Windows

- Vista / Server 2008 supports TCP auto-tuning
- For other versions, \*careful\* tuning necessary under RegKey

```
HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\  
    Services\Tcpip\Parameters  
        TcpWindowSize
```

# Networking Best Practices: TCP Optimization on Windows

- Turn on Window Scaling and Timestamps

```
Tcp1323Opts = 3
```

- Set TCP Window Size to BDP

```
GlobalMaxTcpWindowSize = <BDP>
```

If desired, tune Window Size at the Interface Level (eg network card level)

```
Tcpip\Parameters\Interfaces\<interfaceGUID>\  
TcpWindowSize
```

# Networking Best Practices

- `SQLNET.AUTHENTICATION_SERVICES=(NTS)`
  - This is a default value in `SQLNET.ORA`, needed for OS authentication (connect / as SYSDBA)
  - It should be left at default on server side.
- Use SecureFile LOBs
  - NET stack optimizations provide very high throughput limited only by the underlying hardware

# File System Best Practices

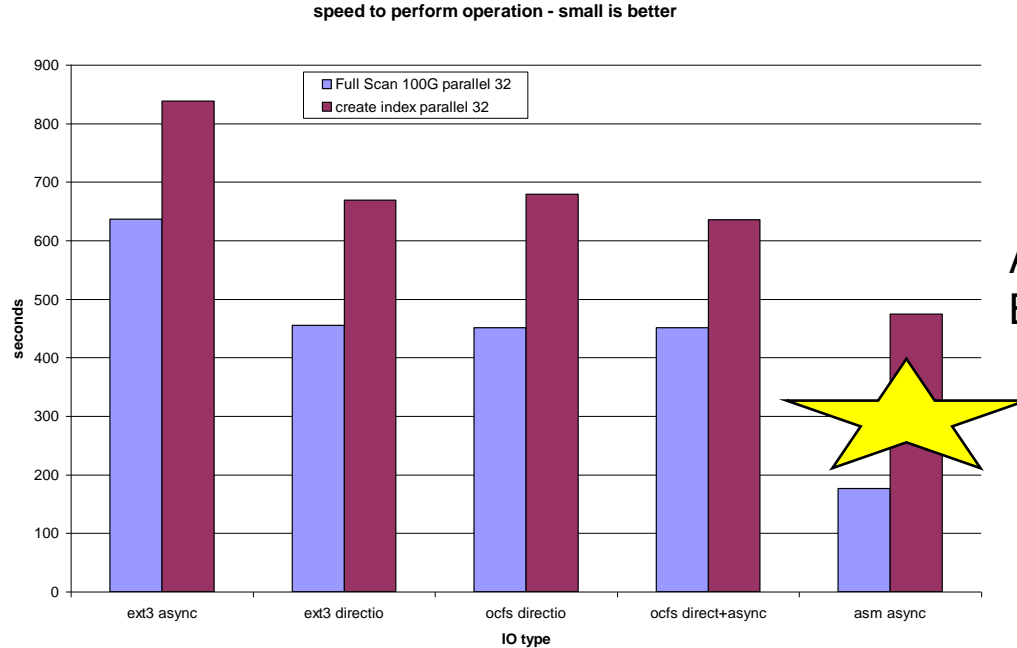
- Use ASM – whether single-instance or RAC – use most recent version of ASM
- Benefits
  - Don't need to move datafiles around
  - Don't need to take tablespaces offline
  - Add disks with no downtime
- If you don't use ASM, but want to use raw devices:
  - Use volume mount points to mount raw devices onto directories
  - Use this mount point as the file name for raw devices.



# Provides Best Performance

- ASM provides equivalent performance to RAW
  - Database instance directly accesses data on disks
  - ASM not in path between instance and storage
- Sun ASM vs RAW benchmark
  - ASM supported 80% more throughput with 50% shorter response
- CERN testing on 11.2 Beta: “ACFS much faster than ext3 with comparable or less CPU usage”

# ASM vs ext3 and OCFS full scan and index build

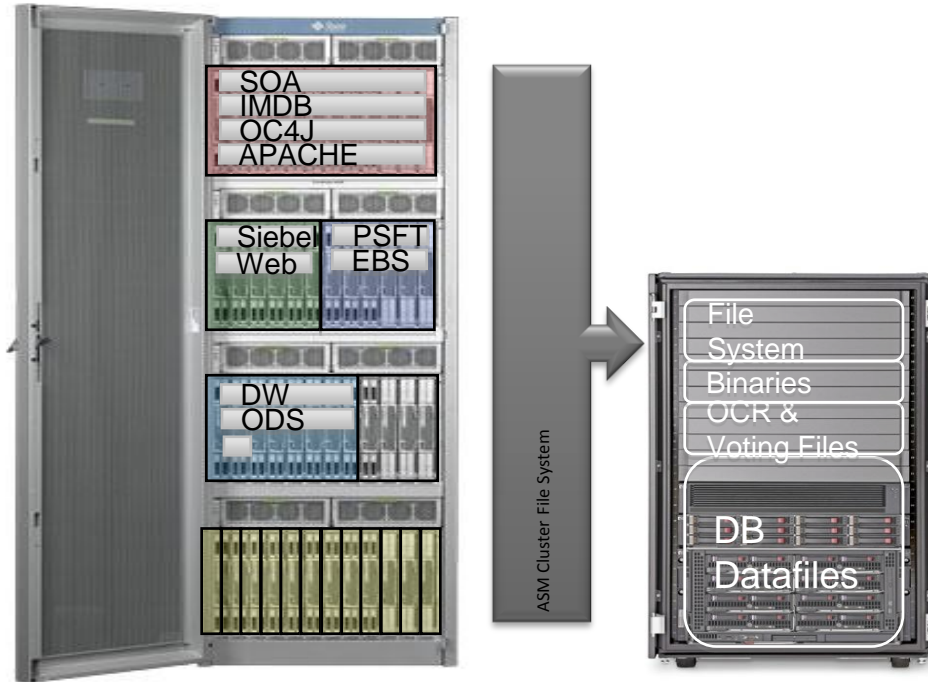


ASM has  
Best Performance

# Stores All Data

## ASM Cluster File System (ACFS)

New in  
11.2



- General purpose scalable file system
- Accessible through NAS protocols (NFS, CIFS)
- Multi OS platform (Linux and Windows at initial release)
- Dynamic Volume Management Supported
- Read Only Snapshots Supported

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# Memory Best Practices

- 11g: Use MEMORY\_TARGET for automatic management of combined SGA and PGA
- 10g and earlier:
  - Control SGA Memory by using SGA\_TARGET parameter
  - Control PGA Memory by using PGA\_AGGREGATE\_TARGET parameter

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# 32 bit Memory Best Practices

- Don't use 32-bit Windows! Move to 64-bit Windows if at all possible!!! Memory issues on Win32 are a pain to deal with.
- Increase addressable memory available to the Oracle process by adding /3GB switch to boot.ini file:  
`multi(0)disk(0)rdisk(0)partition(1)\WINNT="Microsoft Windows 2000 Advanced Server" /fastdetect /3GB`
- Reboot server to enable

# 32 bit Memory Best Practices

- Must monitor kernel memory closely to prevent instability of operating system
- See Metalink Notes 46001.1 and 297498.1
- See Microsoft KB article 297812

# Monitoring Memory

- Key Items to Monitor for Memory Usage:
  - Perfmon - Virtual Bytes for oracle.exe to see total memory used by the process
  - Total Pool Non-Paged Bytes – Memory Counter
    - If grows close to 128MB, operating system instability will occur
    - If this grows too high, look for memory leaks
  - Free System Page Table Entries (PTE's) – Memory Counter
    - Should never fall below 7500 or so
    - /USERVA=2560 switch in boot.ini will help prevent this



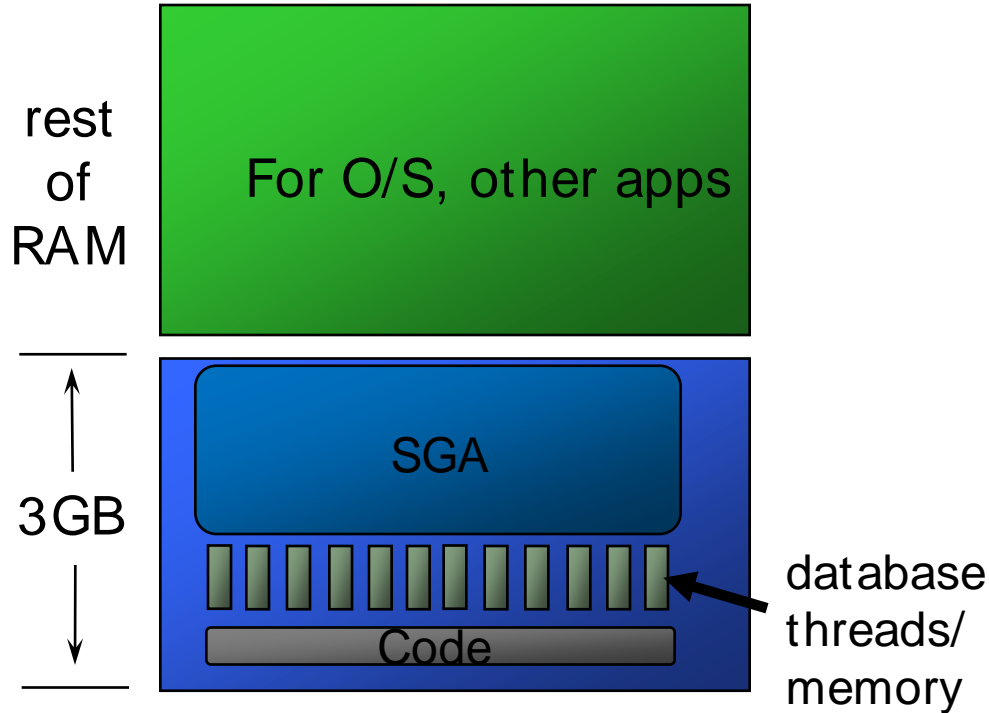
# Using ORASTACK

- Each thread within Oracle process is provided 1MB reserved stack space
- Reduce to 500k without consequence on most systems:  
C:\ orastack tnslnr.exe 500000  
C:\ orastack oracle.exe 500000
- Be sure to run on BOTH tnslnr.exe and oracle.exe

# Using ORASTACK

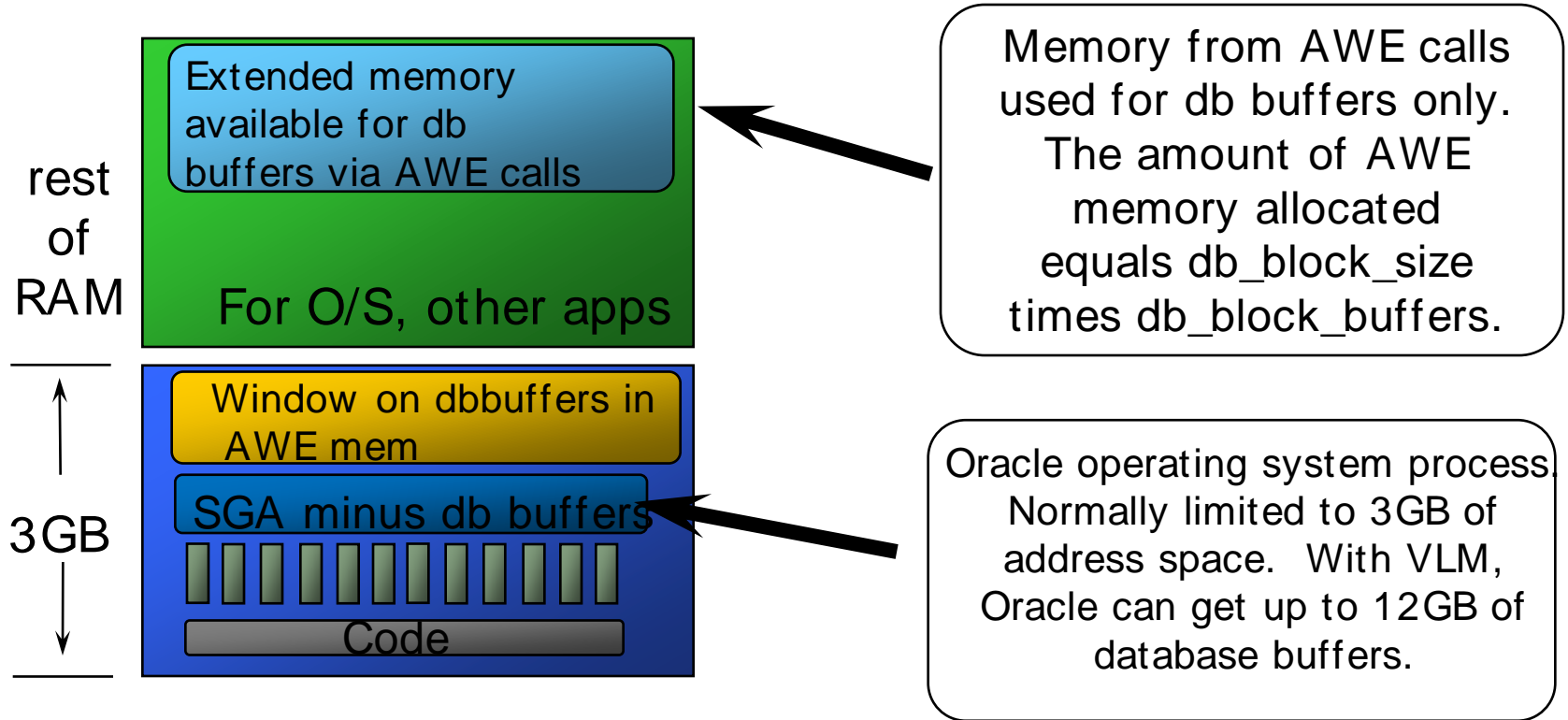
- Stop processes before running Orastack
- If you apply a patch, you must re-run Orastack
- Make sure to test your system to be sure 500k is OK
- See Metalink Note 46001.1 for more information

# 32-bit: VLM Support



Windows Server  
Memory Limits (32-bit)  
Standard Edition:  
4GB  
Enterprise Edition:  
32GB  
Datacenter Edition:  
64GB

# 32-bit: VLM Support



# Implementing AWE

- Use AWE with Oracle by adding initialization parameter `USE_INDIRECT_DATA_BUFFERS`
- Use `DB_BLOCK_BUFFERS` instead of `DB_CACHE_SIZE`
- With AWE, database buffer cache can be increased up to roughly 12 GB
- Default value for `AWE_WINDOW_MEMORY` is 1 GB
- See Metalink Note 225349.1 for more information

# Best Practices for 32-Bit Memory

- Use Automatic Workload Repository (AWR) to monitor cache hit ratios and shared\_pool stats, etc. Make sure that values are not too high
- When implementing AWE be aware that using AWE disables Automatic Memory Management features (SGA\_TARGET cannot be used when USE\_INDIRECT\_DATA\_BUFFERS is set).

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# Oracle on 64-bit Windows

- Long history of supporting 64-bit databases on other platforms
- Interoperability between 32-bit clients and 64-bit servers and vice versa
- Improved performance, availability and scalability



# 64-bit: Migration

- 32-bit to 64-bit upgrade process is simple
  - 32-bit data files are compatible with 64-bit DB
  - Only recreate control file if necessary (eg file location changes)
- No need to recreate the database
- Full export and import not required
- Database Upgrade Assistant automates process
- Transparent migration for end-user applications
  - No changes required to existing client applications when running against 64-bit database

# 64-Bit Best Practices

- Use SP2 or later for Windows Server 2003 to avoid OS performance bug. (Fixed in 2008)
- Run correct 64-Bit version of Oracle for the architecture – I.e. 64-Bit Oracle for AMD or 64-Bit Oracle for Itanium.
- 32-Bit Oracle db not supported on 64-Bit platforms
- 32-bit Client is supported on x64 64-bit platforms
- Enable Large Pages

# 64-Bit Best Practices

- If system has more than 4G use sga\_target (and not memory target).
- Having a fixed SGA with large pages (compared to dynamically growing SGA) has many benefits, in particular, stability.



High Availability

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HARDWARE.  
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# High Availability Solutions

- HA becomes essential as databases are critical component of business
- HA Goals: Minimize downtime to your company and your customers
- Solutions for Windows Environments
  - Real Application Clusters (RAC)
  - Oracle Fail Safe
  - Data Guard (DG)
  - Maximum Availability Architecture (MAA)

# Fail Safe Best Practices

- One database per group
  - Separate production from non-production databases into different groups
- Multiple physical disks to be separated into different groups
- Failback and Restart properties should be reviewed for business needs
  - Not all properties need to fail over

# Real Applications Clusters

- Use RAC for scalability and High Availability
  - Add instances against same database files providing more Oracle processes and increasing number of users
  - Provides unique scalability on Windows that no other vendor offers
- Clustered databases supported on Windows platforms since version 7.3.4

# Real Applications Clusters

- Oracle provides platform independent Oracle Clusterware to handle failover of services to surviving nodes
- Uses Oracle's own clustering software, it does not depend on MSCS



# Oracle Data Guard

- Data Guard is Oracle's Disaster Recovery product which maintains and monitors one or more standby databases to protect enterprise data from failures, disasters, errors, and corruptions
- Standby databases, which can be located across large geographic regions away from the primary database, can be switched to the production role if a problem occurs with the primary

# Oracle Data Guard

- Can use different Windows versions for primary and standby (2003 for primary, 2000 for standby)
- DG is free with Enterprise Edition of RDBMS

# For More Information

- Sessions
  - Tue 10:15-11:15 AM: Best Practices for Oracle Database and Client Deployment on Windows (Moscone South 302)
  - Tue 11:45-12:45 PM: What's New for Oracle Database 11g Release 2 on Windows? (Moscone South 302)
  - Wed 1:15-2:15 PM: Net Services: Best Practices for Performance, Scalability and High Availability (Moscone South 303)

# More Oracle on Windows Resources

- .Windows Technology Center
  - <http://otn.oracle.com/windows>
- For more questions
  - [christian.shay@oracle.com](mailto:christian.shay@oracle.com)

# Q&A

# Hardware and Software

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# Engineered to Work Together

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