Tips Learned Implementing Oracle Solutions With Linux on IBM System z (Part I & II)

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Agenda

- Hardware Setup
- z/VM / LPAR
- Linux
- CPU
- Memory
- I/O
- Networking
- Oracle

Part 1

Part 2
Hardware setup - network

- Use latest network cards and attachments
  - today: OSA4
  - Continuous improvements

- Plan for direct attached OSA cards for performance critical servers

- Define and use Hipersockets for LPAR-LPAR communication
OSA4 throughput improvements

LPAR 10 Gbit MTU 1492 - throughput improvement vs OSA3

- OSA4
- OSA4 + GRO/TSO
OSA4 CPU savings

LPAR 10 Gbit MTU 1492 - CPU savings server vs OSA3
General I/O layout for FICON/ECKD

- The dasd driver starts the I/O on a subchannel
- Each subchannel connects to all channel paths in the path group
- Each channel connects via a switch to a host bus adapter
- A host bus adapter connects to both servers
- Each server connects to its ranks

Diagram:
- Application program
- VFS
- LVM
- Multipath
- dm
- Block device layer
- Page cache
- I/O scheduler
- dasd driver

Diagram shows subchannels and channel paths connecting to servers and HBAs.
The SCSI driver finalizes the I/O requests
The zFCP driver adds the FCP protocol to the requests
The qdio driver transfers the I/O to the channel
A host bus adapter connects to both servers
Each server connects to its ranks
A storage pool striped volume (rotate extents) is defined on a extent pool consisting of several ranks. It is striped over the ranks in stripes of 1 GiB. As shown in the example, the 1 GiB stripes are rotated over all ranks.
A storage pool striped volume

- uses disk drives of multiple ranks
- uses several device adapters
- is bound to one server
## DS8000 storage pool striped volume (3)

<table>
<thead>
<tr>
<th></th>
<th>LVM striped logical volumes</th>
<th>DS8000 storage pool striped volumes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Striping is done by...</td>
<td>Linux (device-mapper)</td>
<td>Storage server</td>
</tr>
<tr>
<td>Which disks to choose...</td>
<td>plan carefully</td>
<td>don't care</td>
</tr>
<tr>
<td>Disks from one extent pool...</td>
<td>per rank, alternating over servers</td>
<td>out of multiple ranks</td>
</tr>
<tr>
<td>Administrating disks is...</td>
<td>complex</td>
<td>simple</td>
</tr>
<tr>
<td>Extendable...</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“gluing” disks together as linear LV can be a workaround</td>
</tr>
<tr>
<td>Stripe size...</td>
<td>variable, to suit your workload (64KiB, default)</td>
<td>1GiB</td>
</tr>
</tbody>
</table>
Hardware setup - storage recommendations

- Keep as many parts busy at each level as you can
  - Multiple storage servers, CHPIDs, HBAs, ranks, spindles
- Plan for capacity on each level!
- Use storage pool striping
Agenda

- Hardware Setup
- z/VM / LPAR
- Linux
- CPU
- Memory
- I/O
- Networking
- Oracle
z/VM reorder processing

• The cost of reorder is proportional to the number of **resident** frames for the virtual machine

• Delay of ~ 1s per 8 GB resident memory, the whole guest is stopped

• For details see: [http://www.vm.ibm.com/perf/tips/reorder.html](http://www.vm.ibm.com/perf/tips/reorder.html)

• Recommendation: Turn reorder off for larger Oracle guests  
  • **SET REORDER OFF FOR** .....
z/VM - qioassist

- Hardware assist to reduce Hypervisor overhead
- Enable for all FCP and OSA / Hipersocket channels
- Reduces the number of SIE exits
  - Shorter path length
  - Less cache pollution
z/VM – stay current and plan ahead

- z/VM 6.3 – “Making room to grow your business”
  - Support for 1 TB memory per LPAR
  - Reordering replaced
  - Support for HiperDispatch
    - Dispatching affinity!

- High Performance FICON
  - APAR VM65041 for z/VM 6.2
z/VM – monitor your system

- Collect z/VM performance data as default
  - Other tooling from ISVs / IBM works as well

- Really needed if debugging performance problems under z/VM
z/VM or LPAR

- Larger guests can monopolize a z/VM
- There is always some overhead with virtualization
- Some high end production is better placed in separate LPARs
  - Resource sharing still possible except memory
- However use z/VM for
  - Many low utilized guests
  - Test and development systems
  - Fast changing environments
  - Guests with (planned) peak workloads at different times
  - Memory over commit needed
Agenda

• Hardware Setup
• z/VM / LPAR
• Linux
• CPU
• Memory
• I/O
• Networking
• Oracle
Linux configuration

• Disable all not needed services
  • splash, postfix, nfs, ……

• Disable selinux
  • Kernel parameter selinux=0

• Disable cgroup memory
  • Kernel parameter cgroup_disable=memory
  • Saves 1% of memory per guest.
Oracle RPM checker

• Before you do your first Oracle Install – run the Oracle rpm checker!

• Oracle Note -> Getting Started - 11gR2 Grid Infrastructure, SI(Single Instance), ASM and DB (IBM: Linux on System z) -(1306465.1)

• These rpms are "dummy" rpms that have dependency checks against all the required rpms for both Grid Infrastructure and Database installs.

• Must have an Oracle support ID to download

RHEL5 - 11.2 Grid Infrastructure, SIHA, DB Install
RHEL6 - 11.2 Grid Infrastructure, SIHA, DB Install
SLES 10 - 11.2 Grid Infrastructure, SIHA, DB Install
SLES 11 - 11.2 Grid Infrastructure, SIHA, DB Install
SLES 11 SP2+ & Red Hat 6.2+ – Oracle Install Warnings for Oracle 11.2.0.3

- Ignore the following Oracle Installer Warnings

Some of the minimum requirements for installation are not completed. Review and fix the issues listed in the following table, and recheck the system.

<table>
<thead>
<tr>
<th>Checks</th>
<th>Status</th>
<th>Fixable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swap Size</td>
<td>Ignored</td>
<td>No</td>
</tr>
<tr>
<td>Packages</td>
<td></td>
<td></td>
</tr>
<tr>
<td>libstdc++43-4.3.4_20091019-0.7.35 (s390x)</td>
<td>Ignored</td>
<td>No</td>
</tr>
<tr>
<td>libgcc43-4.3.4_20091019-0.7.35</td>
<td>Ignored</td>
<td>No</td>
</tr>
<tr>
<td>compat-libstdc++-33-3.2.3-47.3</td>
<td>Ignored</td>
<td>No</td>
</tr>
</tbody>
</table>

- SLES 11 SP1 compat-libstdc++-33.3.2.3-47.3 is not available on SuSE 11, rpm libstdc++-33 provides the required files.
- SLES 11 SP2 the libstdc++43 and libgcc43 checks fail as the rpm has changed to libstdc++46 providing both the 32-bit version and 64-bit versions of libstdc++43-devel rpms are installed – these are not problems.
SLES 11 SP2 – New KVM Service

- Oracle 11gR2 (ASM Single Instance & RAC) may encounter a conflict with the SuSe KVM service in the “/etc/inittab” file for fresh SLES 11 SP2 installs (Upgrades are OK):

```
h1:35:respawn:/etc/init.d/init.ohasd run >/dev/null 2>&1 </dev/null  - Installed by Oracle
h1:2345:respawn:/sbin/ttyrun hvc1 /sbin/agetty -L 9600 %t linux  - Default KVM service
```

- Details see Oracle Note 1476511.1
ASM or LVM

• LVM – Logical Volume Manager in Linux
• ASM – Automated Storage Management provided by Oracle
  • Oracle RAC One and Oracle RAC will require ASM

| pro | LVM | • Direct control on setting and layout  
   |     | • Can choose file system |
| con |     | • Complex setup |

| ASM | • Automated, out of the box environment  
 |     | • Very good integration with Oracle  
 |     | • RMAN required for backup |

• Overall recommendation: **ASM**
LVM - disable read ahead, use direct I/O

- Reduce the Linux Read-Ahead for LVM file systems.
  - `lvchange -r none <lv device name>`

- `filesystemio_options=setall`
Linux paging / swappiness

• With the default swappiness setting of 60 Linux does proactive paging

• Oracle data / code on a Linux (or VM) paging disk has a performance hit when it’s needed
  • Observed long (>10s) waits at swap in
  • Guest was sized correctly
  • Guest was using database in the file system without direct I/O

• Recommendation: set swappiness to zero
  • In /etc/sysctl.conf add `vm.swappiness=0`
Collect Linux performance data

- Standalone performance collection in Linux is sysstat
  - [http://sebastien.godard.pagesperso-orange.fr](http://sebastien.godard.pagesperso-orange.fr)

- For standard monitoring use same interval as for your z/VM monitoring

- Always monitor your system

- Include monitoring for disks (default off)

Stay current with your Linux updates

- Check updates for performance enhancements
  - RHEL 5.9
    - VDSO
    - HyperPAV
  - SLES 11 SP2
    - GRO / TSO

- Security updates need to be considered as well
Agenda

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- Oracle
Sizing Consolidated CPU consumption – equivalent MIPS

2937 MIPS
Monitoring CPU Run Levels / Oracle Parallel Query

Watch the run queue!

# vmstat 3 (on 2 Virtual CPU Machine)

<table>
<thead>
<tr>
<th>proc</th>
<th>-----------memory----------</th>
<th>-------swap-----</th>
<th>------io------</th>
<th>-----system--</th>
<th>-----cpu-----</th>
</tr>
</thead>
<tbody>
<tr>
<td>r</td>
<td>swpd</td>
<td>free</td>
<td>buff</td>
<td>cache</td>
<td>si</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>276900</td>
<td>286468</td>
<td>1164</td>
<td>468472</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>276896</td>
<td>284772</td>
<td>1256</td>
<td>468900</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>276888</td>
<td>272052</td>
<td>1392</td>
<td>470320</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>275672</td>
<td>8988</td>
<td>1228</td>
<td>464564</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>273636</td>
<td>8884</td>
<td>652</td>
<td>489576</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>271560</td>
<td>8580</td>
<td>788</td>
<td>536964</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>267576</td>
<td>8732</td>
<td>1068</td>
<td>591056</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>283124</td>
<td>6168</td>
<td>240</td>
<td>586176</td>
</tr>
<tr>
<td>0</td>
<td>8</td>
<td>307192</td>
<td>5840</td>
<td>432</td>
<td>614808</td>
</tr>
<tr>
<td>16</td>
<td>12</td>
<td>307192</td>
<td>6668</td>
<td>136</td>
<td>572948</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>307192</td>
<td>7796</td>
<td>120</td>
<td>570384</td>
</tr>
</tbody>
</table>

- **r** –run queue –how many processes currently waiting for CPU
  - try to keep < # of Virtual IFLs for Oracle Parallel Query

- **b** – how many processes waiting in uninterruptible sleep

- Steal time (**st**) is the percentage of time a virtual CPU waits for a real CPU while the hypervisor is servicing another virtual processor.
Oracle Parallelism

Default Value:

\[
\text{PARALLEL\_MAX\_SERVERS} = (\text{CPU\_COUNT} \times \text{PARALLEL\_THREADS\_PER\_CPU} \times 10)
\]

- If too many query server processes, memory contention (paging), I/O contention, or excessive context switching can occur
- Contention can reduce system throughput to a level lower than if parallel execution were not used.
- Can utilize **Oracle Consumer Group** to limit processes for certain types of users/jobs
CPUPLUGD

- CPUPLUGD Daemon can be configured to add or reduce the number of Virtual processors based on the load

- Oracle dynamically changes the Oracle internal parameter "cpu_count" based on the number of Virtual processors available.
  - This should be the default!

- Explicitly setting cpu_count will disable the automatic adaption of Oracle DB to cpuplugd changes

- CPUPLUGD configuration recommendations
  - Need fast sampling interval (1s)
  - Create sensitive configuration for CPU add
VDSO – Linux cpu Improvements

- **Virtual Dynamically-linked Shared Object (VDSO)** is a shared library provided by the kernel. This allows normal programs to do certain system calls without the usual overhead of system calls like switching address spaces.

- On a z196 system for example by using the VDSO implementation six times reduction in the function calls are possible.

- Newer Linux distributions (RHEL 5.9 & 6.x, SLES 11) have this feature and it's enabled by default.

- Oracle calls Linux `gettimeofday()` hundreds of times a second for reporting statistics.

- VDSO reduces cpu cost, especially useful in virtualized environments.
Agenda

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- Linux
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- Memory
- I/O
- Networking
- Oracle
Memory Sizing Oracle on System z Linux and 11gR2

- Customer attempted install 11gR2 with 512mb – **could not re-link on install.**
  - Oracle recommends **4GB** for all Linux Platforms, **smallest we would suggest is 2GB of Virtual Memory for a Single Oracle instance.**

- One customer experienced consumed 200mb more RAM 10gR2 to 11gR2

- **Right Size** the Virtual Memory based on What is needed:
  - **All SGA’s (including ASM)** – consider Large Pages
  - **Oracle PGA’s** (not eligible for Large Pages)
  - **User Connections** to the database (4.5mb – not eligible)
  - **Linux Page Tables** and **Linux Kernel Memory**
  - Try NOT to oversize the Linux Guest under z/VM, use VDISKs

- Production workloads 1 to **1.5:1** Virtual to Physical Memory, for Test and Dev **2 to 3:1** are possible.
Swap Sizing Oracle on System z Linux and 11gR2

- Example of VDISK for 1st and or 2nd Level Swap with higher priority and then DASD as a lower priority swap in case of an unexpected memory pattern.

<table>
<thead>
<tr>
<th># swapon -s</th>
<th>Filename</th>
<th>Type</th>
<th>Size</th>
<th>Used</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>/dev/dasdo1</td>
<td>partition</td>
<td>131000</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>/dev/dasdp1</td>
<td>partition</td>
<td>524216</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>/dev/mapper/u603_swap3</td>
<td>partition</td>
<td>6291448</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

- You may want to recycle the swap from time to time to free swap slots (check swapcache in /proc/meminfo)
  - Ensure there is enough memory (e.g. at night)
  - drop caches
  - swapoff / swapon
Consider Using Linux Huge Pages for Oracle Database Memory

→ In general 10-15% can be gained by the reduction in CPU usage as well as having a lot more memory for applications that would be consumed in Linux Page Tables…
HugePage Considerations:

- Can not use `MEMORY_TARGET` with Huge Pages.
  - Set manually (`SGA_TARGET`, `PGA_AGGREGRATE_TARGET`)

- Not swappable: Huge Pages are not swappable

- General guideline consider when combined Oracle SGA’s are greater than 8 GB (particularly if a lots of connections)

- Decreased page table overhead; more memory can be freed up for other uses. For example more Oracle SGA memory, and less physical I/O’s (See also Document 361468.1)
Use Huge Pages Even under z/VM

• Under z/VM (which has 4K pages) it’s still recommended to use Huge Pages for SGA’s > 10GB particularly with many connections

• Saves Memory that would otherwise be used for pagetables

• Stability for user process spikes (avoiding swap)

• Less work to manage smaller number of pagetables

• ~10% improvement for memory intensive databases
/proc/meminfo – customer example (before)

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MemTotal:</td>
<td>82371500 kB</td>
</tr>
<tr>
<td>MemFree:</td>
<td>371220 kB</td>
</tr>
<tr>
<td>Buffers:</td>
<td>4956 kB</td>
</tr>
<tr>
<td>Cached:</td>
<td>50274732 kB</td>
</tr>
<tr>
<td>SwapCached:</td>
<td>2248480 kB</td>
</tr>
<tr>
<td>Active:</td>
<td>53106388 kB</td>
</tr>
<tr>
<td>Inactive:</td>
<td>2164644 kB</td>
</tr>
<tr>
<td>HighTotal:</td>
<td>0 kB</td>
</tr>
<tr>
<td>HighFree:</td>
<td>0 kB</td>
</tr>
<tr>
<td>LowTotal:</td>
<td>82371500 kB</td>
</tr>
<tr>
<td>LowFree:</td>
<td>371220 kB</td>
</tr>
<tr>
<td>SwapTotal:</td>
<td>16408504 kB</td>
</tr>
<tr>
<td>SwapFree:</td>
<td>9834092 kB</td>
</tr>
<tr>
<td>Dirty:</td>
<td>468 kB</td>
</tr>
<tr>
<td>Writeback:</td>
<td>0 kB</td>
</tr>
<tr>
<td>AnonPages:</td>
<td>2743884 kB</td>
</tr>
<tr>
<td>Mapped:</td>
<td>48976112 kB</td>
</tr>
<tr>
<td>Slab:</td>
<td>243944 kB</td>
</tr>
<tr>
<td>PageTables:</td>
<td>26095124 kB</td>
</tr>
<tr>
<td>NFS_Unstable:</td>
<td>0 kB</td>
</tr>
<tr>
<td>Bounce:</td>
<td>0 kB</td>
</tr>
<tr>
<td>CommitLimit:</td>
<td>57594252 kB</td>
</tr>
<tr>
<td>Committed_AS:</td>
<td>62983256 kB</td>
</tr>
<tr>
<td>VmallocTotal:</td>
<td>4211073024 kB</td>
</tr>
<tr>
<td>VmallocUsed:</td>
<td>12028 kB</td>
</tr>
<tr>
<td>VmallocChunk:</td>
<td>4211060796 kB</td>
</tr>
<tr>
<td>HugePages_Total:</td>
<td>0</td>
</tr>
<tr>
<td>HugePages_Free:</td>
<td>0</td>
</tr>
<tr>
<td>HugePages_Rsvd:</td>
<td>0</td>
</tr>
<tr>
<td>Hugepagesize:</td>
<td>2048 kB</td>
</tr>
</tbody>
</table>
### /proc/meminfo – customer example (after)

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MemTotal:</td>
<td>82371500 kB</td>
</tr>
<tr>
<td>MemFree:</td>
<td>7315160 kB</td>
</tr>
<tr>
<td>Buffers:</td>
<td>352624 kB</td>
</tr>
<tr>
<td>Cached:</td>
<td>12824152 kB</td>
</tr>
<tr>
<td>SwapCached:</td>
<td>0 kB</td>
</tr>
<tr>
<td>Active:</td>
<td>4000920 kB</td>
</tr>
<tr>
<td>Inactive:</td>
<td>12309216 kB</td>
</tr>
<tr>
<td>HighTotal:</td>
<td>0 kB</td>
</tr>
<tr>
<td>HighFree:</td>
<td>0 kB</td>
</tr>
<tr>
<td>LowTotal:</td>
<td>82371500 kB</td>
</tr>
<tr>
<td>LowFree:</td>
<td>7315160 kB</td>
</tr>
<tr>
<td>SwapTotal:</td>
<td>18456496 kB</td>
</tr>
<tr>
<td>SwapFree:</td>
<td>18456496 kB</td>
</tr>
<tr>
<td>Dirty:</td>
<td>504 kB</td>
</tr>
<tr>
<td>Writeback:</td>
<td>108 kB</td>
</tr>
<tr>
<td>AnonPages:</td>
<td>3241568 kB</td>
</tr>
<tr>
<td>Mapped:</td>
<td>170176 kB</td>
</tr>
<tr>
<td>Slab:</td>
<td>439912 kB</td>
</tr>
<tr>
<td>PageTables:</td>
<td>318848 kB</td>
</tr>
<tr>
<td>NFS_Unstable:</td>
<td>0 kB</td>
</tr>
<tr>
<td>Bounce:</td>
<td>0 kB</td>
</tr>
<tr>
<td>CommitLimit:</td>
<td>30802308 kB</td>
</tr>
<tr>
<td>Committed_AS:</td>
<td>6001276 kB</td>
</tr>
<tr>
<td>VmallocTotal:</td>
<td>4211073024 kB</td>
</tr>
<tr>
<td>VmallocUsed:</td>
<td>13032 kB</td>
</tr>
<tr>
<td>VmallocChunk:</td>
<td>4211059808 kB</td>
</tr>
<tr>
<td>HugePages_Total:</td>
<td>28164</td>
</tr>
<tr>
<td>HugePages_Free:</td>
<td>1208</td>
</tr>
<tr>
<td>HugePages_Rsvd:</td>
<td>1205</td>
</tr>
<tr>
<td>Hugepagesize:</td>
<td>2048 kB</td>
</tr>
</tbody>
</table>
Agenda

• Hardware Setup
• z/VM / LPAR
• Linux
• CPU
• Memory
• I/O
• Networking
• Oracle
Verify I/O Performance with Oracle Orion

- Oracle ORION Simulates Oracle reads and writes, without having to create a database
- No Longer Download from Oracle – it is now included with Oracle Code in $ORACLE_HOME/bin/orion

```
./orion_zlinux -run oltp -testname test -num_disks 2 -duration 30 -simulate raid0
```

ORION VERSION 11.2.0.0.1
Commandline: -run oltp -testname mytest -num_disks 2 -duration 30 -simulate raid0
This maps to this test: Test: mytest
Small IO size: 8 KB Large IO size: 1024 KB
IO Types: Small Random I/Os, Large Random I/Os
Simulated Array Type: RAID 0  Stripe Depth: 1024 KB
Write: 0% Cache Size: Not Entered
Duration for each Data Point: 30 seconds
Small Columns:, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40
Large Columns:, 0 Total Data Points: 22
Name: /dev/dasdq1  Size: 2461679616
Name: /dev/dasdr1  Size: 2461679616
2 FILEs found.
Maximum Small IOPS=5035 @ Small=40 and Large=0
Minimum Small Latency=0.55 @ Small=2 and Large=0
Kernel I/O Scheduler

- The Linux 2.6 kernel offers a choice of four different I/O schedulers:
  - Noop Scheduler (noop)
  - Deadline Scheduler (deadline)
  - Anticipatory Scheduler (as)
  - Complete Fair Queuing Scheduler (cfq)

- General Linux default is the “cfq” scheduler:
  - Designed to optimize access to physical disks
  - Check in `/sys/block/<device>/queue/scheduler`
    - `noop`  `anticipatory`  `[deadline]`  `cfq`
  - Not suitable for typical storage servers
  - Default configurable by setting the “elevator=[...]” boot parameter in `/etc/zipl.conf`

- Recommend – `deadline`
HyperPAV (1)

• HyperPAV allows multiple IO operations on the same sub channel
• Very important for random access workload with relative small data transfers
• 10-20 HyperPAV aliases per LCU show best performance gains

• Recommendation:
  • enable whenever using ECKD devices
  • Don’t use too many aliases
HyperPAV (2)

ECKD Devices: Scaling HyperPAV aliases

Normalized Transactional throughput and total Disk I/O (read + write)
ECKD / FCP comparison (1)

Comparing FCP and ECKD

Transactional throughput

normalized transactional throughput

<table>
<thead>
<tr>
<th></th>
<th>4 CPUs</th>
<th>6 CPUs</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECKD (20 aliases)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCP (rr_min_io=100)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ECKD / FCP comparison (2)

Comparing FCP and ECKD

CPU cost per transactional throughput

<table>
<thead>
<tr>
<th></th>
<th>FCP</th>
<th>ECKD</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 CPUs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 CPUs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- 90%
- 95%
- 100%
- 105%
- 110%
- 115%
- 120%
ECKD / FCP comparison (3)

- FCP offers better throughput and performance
- ECKD uses less CPU per transaction
- You have to tune both environments
- Recommendation: it depends
Linux multipathing – rr_min_io

• For FCP attached devices multipathing is needed for availability
  • Guidance for SLES11 + RHEL6 is to use multibus

• rr_min_io defines the number of I/O operations that are send to path before switching to the next (round robin)
  • Defined in multipath.conf
  • In RHEL6.2 and up rr_min_io_rq

• The rr_min_io value is storage dependent
  • For DS8K rr_min_io=100 provided good results
  • XIV recommends rr_min_io=15
Linux queue_depth

• Default of 32 generally pretty good
  • Set in /sys/bus/scsi/devices/<SCSI device>/queue_depth

• Reasons to decrease value:
  • Latency problems (pretty rare)
  • Storage subsystem overload

• Reasons to increase value:
  • System with heavy I/O load
  • Storage vendor suggestion / recommendation

• Use with care, due to the overload problem
Separate Redo log files from database (1)

• Conflicting kind of I/O
  • Logs are large sequential writes (good to optimize)
  • Normal database workloads are many small random read / writes
• Storage subsystem can’t optimize if everything put together
• Watch Oracle events “log file sync” and “log file parallel write

• Recommendation: put in different ASM disk groups
Separate Redo log files from database (2)

Data and Logs - Disk Setup

% Total Call Time

- Log file sync
- Log file parallel write

- 4 disks, log + data mixed
- 4 disk data + 2 disks log
Agenda

- Hardware Setup
- z/VM / LPAR
- Linux
- CPU
- Memory
- I/O
- Networking
- Oracle
Networking

- Choose MTU size right
- Network queue length
- SHARE session 12758 - Oracle Networking Alternatives
Choose the Correct Network MTU size

<table>
<thead>
<tr>
<th>netstat –s of Interconnect</th>
<th>MTU Size of 1492 (default)</th>
<th>MTU Size of 8992 (with 8K DB block size)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before reassemblies</td>
<td>43,530,572</td>
<td>1,563,179</td>
</tr>
<tr>
<td>After reassemblies</td>
<td>54,281,987</td>
<td>1,565,071</td>
</tr>
<tr>
<td>Delta assemblies</td>
<td>10,751,415</td>
<td>1,892</td>
</tr>
</tbody>
</table>
Network Queue Length

• The device queue length should be increased from the default size of 1000 to at least 2000 using `sysctl`:

```
sysctl -w net.core.netdev_max_backlog =2000
```

Oracle RAC - Scaling device queue length

<table>
<thead>
<tr>
<th>Device queue length</th>
<th>Normalized transaction throughput</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 (default)</td>
<td>100%</td>
</tr>
<tr>
<td>2000</td>
<td>140%</td>
</tr>
<tr>
<td>2500</td>
<td>120%</td>
</tr>
</tbody>
</table>
Networking: Hipersockets Checksumming Disable

• HiperSockets does not require network checksum since it is a memory to-memory operation.

– To save CPU cycles, switch checksumming off:
  
  **SUSE SLES10:** in `/etc/sysconfig/hardware/hwcfg-qeth-bus-ccw-0.0.F200` add `QETH_OPTIONS="checksumming=no_checksumming"`

  **SUSE SLES11:** in `/etc/udev/rules.d/51-qeth-0.0.f200.rules` add
  `ACTION="add", SUBSYSTEM="ccwgroup", KERNEL="0.0.f200", ATTR{checksumming}="no_checksumming"

  **Red Hat:** in `/etc/sysconfig/network-scripts/ifcfg-eth0` add
  `OPTIONS="checksumming=no_checksumming"`
Oracle Network Configuration Testing

- VSwitch (Active / Passive), Linux Bonding, VSwitch Link Aggregation and Oracle’s HAIP
- Tests included shared OSA cards across multiple System z machines.
- Separation of Interconnect traffic (application server as well) including VLANs improves performance and stability.
- Multiple Write/Write intensive databases performed best with Link Aggregation or HAIP
Agenda

- Hardware Setup
- z/VM / LPAR
- Linux
- CPU
- Memory
- I/O
- Networking
- Oracle
IBM continues to invest aggressively in Java for System z, demonstrating a rich history of innovation and performance improvements.

http://www.centerline.net/review/#/3332_B

Timelines and deliveries are subject to change.
Linux on System z and Java7SR3 on zEC12:
64-Bit Java Multi-threaded Benchmark on 16-Way

~12x aggregate hardware and software improvement comparing Java5SR4 on z9 to Java7SR3 on zEC12
LP=Large Pages for Java heap  CR=Java compressed references
Java7SR3 using -Xaggressive + 1Meg large pages

(Controlled measurement environment, results may vary)
Oracle 11g OLTP improvements

Comparison Oracle 10g vs Oracle 11g Database

User scaling - transactional throughput

- Recommendation: Upgrade if not already done!
Oracle 11.2.0.3 Improvements

• Oracle’s **VKTM** process uses slightly less CPU minutes
  • (about 0.08 vs. 0.09 with 11.2.0.2)

• Great improvements with **ora_dia0** process.
  • (about 0.07 sec cpu/minute vs. 0.28 with 11.2.0.2)

• Only Install the database modules that are needed
  • DB installed with **NO** options
    The "gettimeofday" function is called 300 times every 15 seconds.

  • DB installed with **all** options : (java, xml, Text, spatial, APEX, etc ....... )
    The "gettimeofday" function is called 1500 times every 15 seconds.
Choose the Best Oracle Audit Options

- Problem: substantial additional CPU load depending on where the data is being stored
- Details see: [Oracle Database Auditing: Performance Guidelines](#)

- Investigate if creating an OS audit file is an option for your organization
- Oracle will create an audit file in the Oracle file system for system operations anyway
### Oracle RMAN Backup Compression

<table>
<thead>
<tr>
<th>Backup Compression</th>
<th>Backup Time</th>
<th>Compression Size Source DB - 1.29 GB</th>
<th>% Compression / Input MB/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Basic’ 10gR2 (BZIP2) Compression</td>
<td>02:48 (168 s)</td>
<td>278.95 MB</td>
<td>78.9 % / 7.89 MB/s</td>
</tr>
<tr>
<td>‘High’ 11gR2 (BZIP2) Compression</td>
<td>08:41 (521 s)</td>
<td>224.82 MB</td>
<td>83.0 % / 2.54 MB/s</td>
</tr>
<tr>
<td>‘Medium’ (ZLIB) Compression</td>
<td>01:08 (68 s)</td>
<td>295.53 MB</td>
<td>77.6 % / 19.46 MB/s</td>
</tr>
<tr>
<td>‘Low’ (LZO) Compression</td>
<td>00:28 (28 s)</td>
<td>357.03 MB</td>
<td>73.0 % / 47.26 MB/s</td>
</tr>
</tbody>
</table>

- **RMAN Command** -> **CONFIGURE COMPRESSION ALGORITHM ‘Low’**
- **Oracle Advanced Compression Feature** required for Low, Medium, High
- **Very High CPU** observed with BZIP2
Oracle Optimizer Hints

Oracle calculates the cpu cost for a sql query plan with:

- number cores (cpu_count)
- optimizer_mode (all_rows, first_rows etc) and
- the number of rows and Bytes in table.

<table>
<thead>
<tr>
<th>Before updating System Statistics</th>
<th>After updating System Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQL&gt; select * from sys.aux_stats$ where name='SYSSTATS_MAIN';</td>
<td>SQL&gt; select * from sys.aux_stats$ where name='SYSSTATS_MAIN';</td>
</tr>
<tr>
<td>SNAME</td>
<td>PNAME</td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>SYSSTATS_MAIN</td>
<td>CPU_SPEED</td>
</tr>
<tr>
<td>SYSSTATS_MAIN</td>
<td>IOSEEK_TIME</td>
</tr>
<tr>
<td>SYSSTATS_MAIN</td>
<td>IOTRANSFER_SPEED</td>
</tr>
<tr>
<td>SYSSTATS_MAIN</td>
<td>READ_TIME</td>
</tr>
<tr>
<td>SYSSTATS_MAIN</td>
<td>WRITE_TIME</td>
</tr>
<tr>
<td>SYSSTATS_MAIN</td>
<td>CPU_SPEED</td>
</tr>
<tr>
<td>SYSSTATS_MAIN</td>
<td>DBR</td>
</tr>
<tr>
<td>SYSSTATS_MAIN</td>
<td>MAX_THR</td>
</tr>
<tr>
<td>SYSSTATS_MAIN</td>
<td>SLAVE_THR</td>
</tr>
</tbody>
</table>

SQL> execute dbms_stats.gather_system_stats('stop');

run some workload....

SQL> execute dbms_stats.gather_system_stats('stop');
exec DBMS_STATS.GATHER_SYSTEM_STATS('NOWORKLOAD');

z9:

<table>
<thead>
<tr>
<th>SNAME</th>
<th>PNAME</th>
<th>PVAL1</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYSSTATS_MAIN</td>
<td>CPUSPEEDNW</td>
<td>533</td>
</tr>
</tbody>
</table>

Linux bogomips per cpu: **6510.00**

z196:

<table>
<thead>
<tr>
<th>SNAME</th>
<th>PNAME</th>
<th>PVAL1</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYSSTATS_MAIN</td>
<td>CPUSPEEDNW</td>
<td>2335</td>
</tr>
</tbody>
</table>

Linux bogomips per cpu: **14367.00**

zEC12:

<table>
<thead>
<tr>
<th>SNAME</th>
<th>PNAME</th>
<th>PVAL1</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYSSTATS_MAIN</td>
<td>CPUSPEEDNW</td>
<td>2613</td>
</tr>
</tbody>
</table>

Linux bogomips per cpu: **18115.00**

Should be done for every hardware upgrade
Locking Table Statistics for Large Tables

DBMS_STATS.UNLOCK_TABLE_STATS(ownname => 'USERS', tabname => 'XXX');

DBMS_STATS.GATHER_TABLE_STATS(ownname => 'USERS', tabname => 'XXX', estimate_percent=>1, cascade =>TRUE, degree =>4);

DBMS_STATS.LOCK_TABLE_STATS(ownname => 'USERS', tabname => 'XXX');

Reduces Unnecessary Statistics Collection
Collect Oracle AWR Data

Buffer Hit% = 98.89

Oracle SGA Buffer Pool Advisory

<table>
<thead>
<tr>
<th>P</th>
<th>Size for Est (M)</th>
<th>Size Factor</th>
<th>Buffers for Estimate</th>
<th>Est Phys Read Factor</th>
<th>Estimated Physical Reads</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>256</td>
<td>0.64</td>
<td>16,080</td>
<td>1.11</td>
<td>97,368,882</td>
</tr>
<tr>
<td>D</td>
<td>288</td>
<td>0.72</td>
<td>18,090</td>
<td>1.11</td>
<td>96,868,286</td>
</tr>
<tr>
<td>D</td>
<td>320</td>
<td>0.80</td>
<td>20,100</td>
<td>1.08</td>
<td>94,323,210</td>
</tr>
<tr>
<td>D</td>
<td>352</td>
<td>0.88</td>
<td>22,110</td>
<td>1.05</td>
<td>91,776,695</td>
</tr>
<tr>
<td>D</td>
<td>384</td>
<td>0.96</td>
<td>24,120</td>
<td>1.02</td>
<td>89,228,794</td>
</tr>
<tr>
<td>D</td>
<td>400</td>
<td>1.00</td>
<td>25,125</td>
<td>1.00</td>
<td>87,480,193</td>
</tr>
<tr>
<td>D</td>
<td>416</td>
<td>1.04</td>
<td>26,130</td>
<td>0.98</td>
<td>85,731,549</td>
</tr>
<tr>
<td>D</td>
<td>448</td>
<td>1.12</td>
<td>28,140</td>
<td>0.94</td>
<td>82,232,582</td>
</tr>
<tr>
<td>D</td>
<td>480</td>
<td>1.20</td>
<td>30,150</td>
<td>0.90</td>
<td>78,731,330</td>
</tr>
<tr>
<td>D</td>
<td>512</td>
<td>1.28</td>
<td>32,160</td>
<td>0.86</td>
<td>75,225,110</td>
</tr>
<tr>
<td>D</td>
<td>544</td>
<td>1.36</td>
<td>34,170</td>
<td>0.82</td>
<td>71,715,825</td>
</tr>
<tr>
<td>D</td>
<td>576</td>
<td>1.44</td>
<td>36,180</td>
<td>0.78</td>
<td>68,209,778</td>
</tr>
<tr>
<td>D</td>
<td>608</td>
<td>1.52</td>
<td>38,190</td>
<td>0.72</td>
<td>63,357,042</td>
</tr>
<tr>
<td>D</td>
<td>640</td>
<td>1.60</td>
<td>40,200</td>
<td>0.67</td>
<td>58,494,659</td>
</tr>
</tbody>
</table>

• Predicts 29 (of 87) million block reads could be eliminated over 30 minute period by adding 240 MB of buffer pool cache:
  • 2,000 read IOs /second
  • 16,000 blocks /second
  • 125 MB/second
  • A 33% savings
Log Buffer Size & Redo Log File Size

- Oracle10gR2+ best to let Oracle automatically set the optimal log_buffer size. (i.e. leave unset in the init.ora).
- Check AWR Report - ideally log switches every 15 – 20 minutes.
- If log switches more frequent you should increase size of logs.
- If using **fast_start_mttr_target** then can use:

  ```sql
  select optimal_logfile_size from v$instance_recovery;
  ```
Oracle Resource Manager - (resmgr:cpu quantum Wait Event)

1) Modify Oracle Initialization parameter - `resource_manager_plan = ''`

2) Additionally You need disable the Maintenance Window Resource Plan

```
select window_name,RESOURCE_PLAN
from DBA_SCHEDULER_WINDOWS;
```

<table>
<thead>
<tr>
<th>WINDOW_NAME</th>
<th>RESOURCE_PLAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>MONDAY_WINDOW</td>
<td>DEFAULT_MAINTENANCE_PLAN</td>
</tr>
</tbody>
</table>

```
execute dbms_scheduler.set_attribute('MONDAY_WINDOW','RESOURCE_PLAN','');
```

<table>
<thead>
<tr>
<th>WINDOW_NAME</th>
<th>RESOURCE_PLAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>MONDAY_WINDOW</td>
<td></td>
</tr>
</tbody>
</table>
Oracle’s Remote Diagnostic Agent (RDA) Reports – Note: 314422.1

List of Diagnostic Problems
Using: SHOW PROBLEM -ALL -ORDERBY LASTINC_TIME DSC
From: /opt/oracle/diag/rdbms/edpsprd/edpsprd

<table>
<thead>
<tr>
<th>Problem ID</th>
<th>Problem Key</th>
<th>Last Incident</th>
<th>Last Incident Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>ORA 4031</td>
<td>516429</td>
<td>2013-01-12 12:33:39.529000-05:00</td>
</tr>
<tr>
<td>6</td>
<td>ORA 445</td>
<td>411813</td>
<td>2013-01-08 20:06:34.734000-05:00</td>
</tr>
<tr>
<td>7</td>
<td>ORA 240</td>
<td>381339</td>
<td>2012-12-19 19:59:01.195000-05:00</td>
</tr>
<tr>
<td>5</td>
<td>ORA 600 [15709]</td>
<td>246899</td>
<td>2012-08-25 05:41:55.184000-04:00</td>
</tr>
<tr>
<td>2</td>
<td>ORA 7445 [kggmd5Process()+26]</td>
<td>13410</td>
<td>2011-12-12 18:16:11.498000-05:00</td>
</tr>
<tr>
<td>3</td>
<td>ORA 600 [SKGMA]</td>
<td>13209</td>
<td>2011-12-11 13:39:00.697000-05:00</td>
</tr>
<tr>
<td>1</td>
<td>ORA 7445 [kggob()+8490]</td>
<td>9169</td>
<td>2011-12-06 12:57:10.293000-05:00</td>
</tr>
</tbody>
</table>

Current CPU Hogs / Top 15 by CPU Time

<table>
<thead>
<tr>
<th>F S UID</th>
<th>PID</th>
<th>PPID</th>
<th>PRI</th>
<th>NI</th>
<th>ADDR</th>
<th>S</th>
<th>WCHAN</th>
<th>STIME</th>
<th>TTY</th>
<th>TIME</th>
<th>CMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>R oracle</td>
<td>23639</td>
<td>1</td>
<td>65</td>
<td>79</td>
<td>0</td>
<td>21093142</td>
<td>stext 13:15</td>
<td>?</td>
<td>04:59:23</td>
<td>ora_j000_edpsprd</td>
</tr>
<tr>
<td>0</td>
<td>R oracle</td>
<td>24814</td>
<td>1</td>
<td>47</td>
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Root CPU Hogs / Top 5 by CPU Time

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Oracle’s OS Watcher Reports – Pro-Active Problem Avoidance

Section 1: Overall Status

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<td>WARNING</td>
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<td>NET</td>
<td>WARNING</td>
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Section 3: Other General Findings

WARNING: Disk high service time observed.

WARNING: Network TCP segments retrans observed.
(Advise: if retransmitted is over 15% of total packets sent, then TCP experiencing timeouts)
(Check: bottleneck may be on the receiving node)
(Check: general network problems can cause TCP retransmissions (too much network traffic))

TCP Errors > 0% Packet Retransmitted:

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<td>segments retransmitted</td>
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<td>resets sent</td>
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<td>failed connection attempts</td>
<td>2426</td>
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</table>

Complete your sessions evaluation online at SHARE.org/SanFranciscoEval
References (1) – Key Oracle Notes

Note 1306465.1 Getting Started - 11gR2 Grid Infrastructure, SI(Single Instance), ASM and DB (IBM: Linux on System z)
Note 1470834.1 - Requirements for Installing Oracle 11gR2 on RHEL 6 on IBM: Linux on System z (s390x)
Note 1290644.1 - Requirements for Installing Oracle 11gR2 on SLES11 on IBM: Linux on System z (s390x) Also review Note:1476511.1 OHASD fails to start on SuSE 11 SP2 on IBM: Linux on System z
Note 1308859.1 Requirements for Installing Oracle 11gR2 on SLES 10 on IBM: Linux on System z (s390x)
Note 1306889.1 Requirements for Installing Oracle 11gR2 on RHEL 5 on IBM: Linux on System z (s390x)
Note 1086769.1 - Ensure you have prerequisite rpms to install Oracle Database & AS10g(midtier) IBM: Linux on System z
Note 1377392.1 How to Manually Configure Disk Storage devices for use with Oracle ASM 11.2 on IBM: Linux on System z
Note 1400185.1 How to Upgrade Oracle Restart i.e. Single Node Grid Infrastructure/ASM from 11.2.0.2 to 11.2.0.3
Note 1276058.1 Oracle GoldenGate Best Practices: Instantiation from an Oracle Source Database
Note 1413787.1 How to completely remove 11.2 Grid Infrastructure, CRS and/or Oracle Restart - IBM: Linux on System z

Note 259301.1 CRS and 10g Real Application Clusters
Note 268937.1 Repairing or Restoring an Inconsistent OCR in RAC
Note 239998.1 10g RAC How to clean up after a failed CRS Install
Note 220970.1 RAC Frequently Asked Questions Topic

Note 1082253 Requirements for Installing Oracle 10gR2 RDBMS on SLES 10 zLinux (s390x)
Note 741646.1 Requirements for Installing Oracle 10gR2 RDBMS on RHEL 5 on zLinux (s390x).
Note 415182.1 DB Install Requirements Quick Reference - zSeries based Linux .

Note 741146.1 Installing Standalone Agent 10.2 on Linux on z

Note 1476511.1 OHASD fails to start on SuSE 11 SP2 on IBM: Linux on System z
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  • Oracle Database on Linux on System z - Disk I/O Connectivity Study
  • Oracle Real Application Clusters on Linux on IBM System z: Set up and network performance tuning
  • Performance of an Oracle 10g R2 Database Import Environment
  • Using the Linux cpuplugd Daemon to manage CPU and memory resources from z/VM Linux guests
  • Oracle Database Auditing: Performance Guidelines

• Presentations
  • Analyzing BI Oracle Workloads Performance Tuning Results – Real Customer Examples

• Other Resources
  • z/VM 6.3 pre-announce
  • Linux on System z Tuning hints & tips
Tips Learned Implementing Oracle Solutions With Linux on IBM System z (Part I & II)

Dr. Eberhard Pasch (epasch@de.ibm.com)
&
David Simpson (simpson.dave@us.ibm.com)

Speakers Company: IBM
Date of Presentation: Thursday, February 7, 2013 (1:30 & 3:00pm)
Franciscan C, Ballroom Level

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