**Quick Tips on Linux HugePages**

The following are a few quick and practical tips on using Linux HugePages on servers that run Oracle databases.

1. **Be generous first and dynamically shrink later**

If you don't want to be accurate in calculating how much memory to be allocated for HugePages, give a rough and very generous estimate. Start all Oracle instances on the box. (To save time, startup nomount is enough.) Check the difference between HugePages\_Free and HugePages\_Rsvd, which is the wastage, because HugePages\_Free includes reserved but not actually used memory. For example,

$ grep Huge /proc/memory

...

HugePages\_Total: 3190

HugePages\_Free: 2458

HugePages\_Rsvd: 2341

2458-2341=117 pages of HugePages or 234 MB memory (assumes 2 MB page size) will never be used. You do NOT have to wait till the instances have been used for a while; that would increase both HugePages\_Free and HugePages\_Rsvd, but not the difference between them.

Now, we can dynamically shrink HugePages to reduce wastage. Let's cut that down to, say, 10 pages. So we should decrease HugePages\_Total by 117-10=107. That is, change 3190 to 3190-107=3083.

# echo 3083 > /proc/sys/vm/nr\_hugepages

cat /proc/sys/vm/nr\_hugepages to confirm the number has been reduced to 3083. Update vm.nr\_hugepages in /etc/sysctl.conf with the correct number so it takes effect on next reboot.

The advantage of over-allocating HugePages at the beginning is that it saves time in getting the memory allocation right on the first try. In addition, dynamically changing HugePages allocation ensures no memory is wasted. In case of shutting down an Oracle instance for an extended period of time, you may choose to lower /proc/sys/vm/nr\_hugepages to give the memory back to OS as well as Oracle PGA. But then if you start back up the previously shutdown instance, you have to increase the nr\_hugepages number, and you may not be able to bring it up fully to the desired number if the available memory is no longer physically contiguous. When that happens, you may or may not be able to start the instance depending on the setting of use\_large\_pages. If it's set to true (default), the instance may be started but it uses no HugePages at all and you'll waste lots of HugePages unless you give up and lower nr\_hugepages back down to give it to OS and wait till next server reboot. So think it over whenever you plan to lower the value.

1. **Seeing is believing**

In older versions of Oracle, the only way to know that HugePages is used is to check /proc/memory. Later versions show the lines in alert\_*sid*.log (Oracle 11*g* example):

Total Shared Global Region in Large Pages = 2370 MB (100%)

Large Pages used by this instance: 1185 (2370 MB)

Large Pages unused system wide = 815 (1630 MB)

Large Pages configured system wide = 2000 (4000 MB)

Large Page size = 2048 KB

The instance in this example here clearly has too much unused HugePages. I would cut configured HugePages down from 2000 to 2000-815+overhead, say, 1200. (The overhead may be related to the number of shared memory segments for the instance as shown in *ipcs* or *sysresv*.)

In 12*c*, the alert.log has these lines instead (excluding the annoying timestamp lines profusely intercalated):

PAGESIZE AVAILABLE\_PAGES EXPECTED\_PAGES ALLOCATED\_PAGES ERROR(s)

4K Configured 5 5 NONE

2048K 1620 1617 1617 NONE

This example only wastes 3 HugePages, corresponding to the following /proc/meminfo values where 10-7=3:

HugePages\_Total: 1620

HugePages\_Free: 10

HugePages\_Rsvd: 7

Beginning with Linux kernel 2.6.29 or Red Hat Enterprise Linux 6 and possibly later minor releases of RHEL 5, /proc/*pid*/smaps provides clues about HugePages usage as well.

# cat /proc/*<any pid of Oracle instance>*/smaps

...

61000000-a7000000 rwxs 00000000 00:0c 1146885 /SYSV00000000 (deleted)

Size: 1146880 kB

Rss: 0 kB

Pss: 0 kB

Shared\_Clean: 0 kB

Shared\_Dirty: 0 kB

Private\_Clean: 0 kB

Private\_Dirty: 0 kB

Referenced: 0 kB

Anonymous: 0 kB

AnonHugePages: 0 kB

Swap: 0 kB

KernelPageSize: 2048 kB ← 2MB HugePage size

MMUPageSize: 2048 kB ← 2MB HugePage size

The last two lines showing 2 MB instead of 4 KB page size are the telltale sign that HugePages are used.

Beginning with Oracle 12*c*, there's yet another way to check the usage. Fixed table x$ksmssinfo (probably Kernel Service, Memory Sga OS (level) Info) not only can tell you whether the memory page size is that of HugePages, but it can even map the SGA components with shared memory segments. The example below is from Oracle 12.1.0.2, where in-memory area is configured. (I removed the ipcs lines irrelevant to this Oracle instance in the example.)

SQL> select "AREA NAME", "SEGMENT SIZE", "SIZE", pagesize, shmid from x$ksmssinfo;

AREA NAME SEGMENT SIZE SIZE PAGESIZE SHMID

-------------------- ------------ ---------- ---------- ----------

imc area rdonly 0 83886080 83886080 2097152 87588873

Variable Size 3288334336 3254779904 2097152 87621642

imc area default 0 3288334336 33554432 2097152 87621642

Redo Buffers 14680064 13844480 2097152 87654411

Fixed Size 4194304 2932736 2097152 87556104

skgm overhead 20480 20480 4096 87687180

SQL> !ipcs -m

------ Shared Memory Segments --------

key shmid owner perms bytes nattch status

...

0x00000000 87556104 oracle 640 4194304 25

0x00000000 87588873 oracle 640 83886080 25

0x00000000 87621642 oracle 640 3288334336 25

0x00000000 87654411 oracle 640 14680064 25

0x639dac14 87687180 oracle 640 20480 25

As you can see, this fixed table tells us HugePages is used except for Oracle's interface to the OS in the generic memory management layer (skgm overhead), which still uses the default 4 KB page size. The largest segment of 3288334336 bytes in size is in two parts: Variable Size (not the same as Variable Size shown by SQL\*Plus command show sga, which excludes buffer cache) used for buffer cache and various SGA pools (shared pool, java pool, large pool), and part of the in-memory area or column store (imc area default 0). The second largest segment of 83886080 bytes contains the other part of in-memory area (imc area rdonly 0). The remaining two segments are obvious. But in spite of small sizes, they don't seem to be fully used.

For more about HugePages, see

http://yong321.freeshell.org/oranotes/HugePages.txt

and the references cited therein.

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