Fast Oracle Parallel Exports on Sun Enterprise™ Servers

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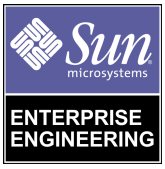

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This article is derived from the Sun BluePrints™ book titled *Backup and Restore Practices for Sun Enterprise™ Servers* by Stan Stringfellow, Miroslav Klivansky, and Michael Barto. The book is a practical guide for IT organizations that are tasked with implementing or revamping a backup / restore architecture. It includes case studies, a methodology, and example runbooks. It addresses issues such as scalability and performance of the backup / restore architecture, criteria for selecting tools and technologies, and tradeoffs that must be considered. It provides technical guidelines for planning the architecture to meet service levels, as well as general advice and guidance. For more information, see `http://www.sun.com/books/blueprints.series.html`.

Why a Parallel Export Script?

This article describes a script that performs very fast Oracle database exports by taking advantage of parallel processing on SMP machines. The performance benefit that this script provides can be nearly linear with the number of CPUs. For example, if you have 10 CPUs available for backups, you may be able to achieve nearly 10 times the normal database export speeds. Thus, this script can be extremely valuable for situations where you need to perform exports of large mission-critical databases that must be highly available.

The script was kindly contributed by its authors, Neal Sundberg and Mike Ellison of QUALCOMM Incorporated. At QUALCOMM, the IT staff routinely runs this script on Sun Enterprise servers to perform an export of a 250 GB database in about two hours. That is very hard to do without using parallel processing on SMP machines.

The Oracle utilities for export and import are basically single-threaded processes that use a single CPU, with the exception of the Oracle feature called *parallel query*. Under certain circumstances, the parallel query feature enables you to spawn parallel processes that perform a SELECT against a large table. You can set the degree of parallelism on the table to the desired number of processes, such as 4 or 8. The parallel query feature takes advantage of multiple CPUs on an SMP machine, possibly breaking down the SELECT statement into separate smaller SELECT statements. However, you might not want to apply parallelism to all of your tables since, in some cases, this can cause problems.

Oracle provides features that support physical backup/restore as well as logical backup/restore. The physical backup/restore features are the normal hot and cold backups, where you simply take static images of the database files (although the hot backups are not quite static). Basically, you copy the database files without really knowing what's in them. With this approach, if you loose a disk drive or if a controller writes bad bytes onto the database, you can recover from the database point of view. You really don't care what is in the tables.

Export/import, on the other hand, takes the logical point of view. An export contains all of the commands required to recreate the database, as if those commands were processed through the Oracle engine. For example, it includes commands such as CREATE DATABASE, ADD DATA FILES, and CREATE TABLE, as well as commands to add data to tables. Thus, an export/import is similar to redoing the entire database by typing everything in by hand.

The export/import approach can be useful for migration, for example from one operating system to another. It can also be useful if you simply want to logically restore part of a database that was lost. Perhaps you only lost one or two tables, and you simply want to restore those tables. You can't use the physical methodology in this situation unless those tables happen to be in their own table space, which is unlikely. There are cases where you might want to use export/import to rebuild your entire system. Maybe you want to defragment your database. This is probably the only way to do it, unless you buy a third party tools.

It is also possible that the export/import approach can supplement normal hot backups, and may sometimes be a lifesaver. For example, suppose your disk RAID failed, and your hot backup failed. In this case, you would be very fortunate if you had a database export available to you, since it could serve as another layer of protection against failure in your system and could allow you to recreate the database. However, an export is only good up to the time it was taken; you can't apply transaction logs. (This is because transaction logs in Oracle use system change numbers, or SCNs. The SCNs help to maintain consistency with the rest of the system. But, SCNs are specific to a particular instance of the database. Since, with export/import utility you are rebuilding the database, the SCN numbers have no significance.) But, missing a day worth of transactions is far better than having no data at all! You probably wouldn't keep database exports around for system failures, except as a third or fourth line of defense, depending on your configuration. However, as mentioned, exports are useful for logical restores.

Consider a situation where a new software program is deployed, and due to a lack of thorough testing, the new program corrupts some tables in your database. You might want to avoid rebuilding the entire database, and simply restore those tables that were affected by the new program. In this case, it would be extremely desirable to have an export image that you could perform imports against. There are other ways you could recover from this situation, but the export/import method may be the fastest. For example, you could rebuild the entire system on the test environment, and bring it up to the point in time just before the failure occurred. You could then open the test system, and export the tables from there. Then, you could use those exports to perform imports into the production system. However, this approach assumes that you have a test system that can be down for a while, and that you have the luxury of the extra time required to go through this entire process.

Exports can be taken in either of two ways. You can do a hot export, with database up and running, and transactions occurring. But, in this case, the backed up tables might be read-inconsistent with each other. So, you could use this approach if you wanted to recover only one table, or perhaps multiple tables if you are willing to perform some SQL+ re synchronization. The second way to do an export is to take the database down and put it into restricted mode (which used to be called DBA mode). Since all tables are consistent, you can completely restore the database from this export.

QUALCOMM does not typically use exports for full database creates, or even as a recovery strategy. But, it can be three layers deep in the recovery strategy. The first layer would be protection from a disk failure, or a hardware failure. This is done with fault tolerant systems, RAID, and so forth. The second layer of protection is an Oracle hot backup. This is the familiar method of putting the database into archive log mode, and then backing up the archive logs between full backups. In this way, if you experience a media failure or a physical system failure, you can recover the entire database from the full and incremental backups on tape. However, in the event that there was a problem with those tapes or the data on them, the export can serve as a last line of defense.

Overview of the `paresh` Approach

The main script used to implement Oracle parallel exports is called `paresh`, for "Parallel Export Shell”. (Also, the author of the script once worked with a consultant from India named Paresh Shah.) The basic approach involves two steps:

1. Take a structure-only export of the entire database. This includes object definitions; objects being tables, indexes, clusters, and so forth. It also includes users, accounts, and so forth. However, no data is exported at this point. This step usually takes about 15 to 20 minutes depending on the size of the database, the

hardware that is used, and so forth. Build a list of database export commands based on this information. To perform this step, you might use an approach such as the one described in "The `list_tbls` Script" on page 5.

2. Export all of the data, one table at a time. There might be thousands of tables in the database. The `paresh` script keeps a specified number of table export processes running at any given time. The `paresh` script spawns processes for each of the export commands that were defined in Step 1, above. The `paresh` script is described in more detail under the heading, "The `paresh` Script" below.

This approach uses a master process that spawns as many slaves as you ask it to. For example, if you set the level of parallelism to 10 processes, the `paresh` script takes the top 10 items in the list of tasks that was produced by the `list_tbls` script, and spawns those 10 processes. As each process completes, `paresh` takes the next item from the list and spawns a new process for that item. In this way, it keeps 10 processes running at all times, until the entire database export is completed. This would make optimal use of a backup server with 10 CPUs.

Note – The `paresh` script is basically a traffic cop for doing "parallel anything". You could conceivably create a completely different set of tasks than those created by the `list_tbls` script, and still make good use of `paresh` to spawn those tasks in an optimal fashion.

The `list_tbls` Script

This SQL*Plus script serves as an example of how to create a file of commands that can be used by the `paresh` script. There are many different approaches. The `list_tbls.sql` script references the standard scripts `table_export.sh` and `full_export_no_rows.sh`. The only parameter to `list_tbls.sql` is the file name of the file to be used by the `paresh` script.

```
whenever sqlerror exit sql.sqlcode;
set pause off;
set pages 0;
set linesize 132;
set feedback off;
set termout off;
column cmd_line format a80
column tick format a3
column sum_bytes format 999,999,999,999
! /bin/rm -f &&1;
spool &&1;
select ’./full_export_no_rows.sh’ from dual;
select ’./table_export.sh ’||owner||’ ’||segment_name cmd_line,
’ # ’ tick,
sum(bytes) sum_bytes
from dba_segments
where segment_type = ’TABLE’
and owner <> ’SYS’
group by owner, segment_name
order by sum(bytes) desc
;
spool off;
exit;
```

The `paresh` Script

This shell file is used to control multiple shell files, in a parallel fashion. It takes two arguments, a file name and the number of processes to run concurrently. The input file is expected to contain a list of all commands to be executed, along with their arguments. The number of parallel processes defaults to 4, but can be set to any positive value.

The usage is:

```
# paresh commands_file parallel_count
```

where:

commands_file is a file that contains a list of commands or shell files to be executed. Because all processing occurs in parallel, there is no guarantee of what the order will be, although the commands are processed from the beginning of the list to the end.

parallel_count is the number of slave processes that should be active simultaneously.

```
#! /bin/sh
#
#-------------------------------------------------------------
# message
#   Establish a timestamp and echo the message to the screen.
#   Tee the output (append) to a unique log file.
#-------------------------------------------------------------
#
message()
{
timestamp=‘date +"%D %T"‘
echo "$timestamp $*" | tee -a $logfile
return
}
```

```
#-------------------------------------------------------------
# get_shell
#   This function is responsible for establishing the next
#   command to be processed.  Since multiple processes might
#   be requesting a command at the same time, it has a built-
#   in locking mechanism.
#-------------------------------------------------------------
#
get_shell()
{
echo "‘date‘ $1 Shell Request $$" >> $lklogfile
                              # debug locking file
while :                       # until a command or end
do
    next_shell=""             # initialize command
    if [ ! -s ${workfile} ]   # if empty file (end)
    then                      #
    break                     # no more commands
    fi                        #
    if [ ! -f $lockfile ]     # is there a lock?
    then                      # not yet...
    echo $$ > $lockfile       # make one
    echo "‘date‘ $1 Lock Obtained $$" >> $lklogfile
                              #debug
    if [ "$$" = "‘cat $lockfile‘" ]
                              # double check that
    then                      # we created it last
        next_shell=‘sed -e q $workfile‘
                              # first line of file
        sed -e 1d $workfile > ${workfile}.tmp # Chop 1st line
        mv ${workfile}.tmp $workfile
                              # rename to work file
        rm -f $lockfile       # turn off lock
        echo "‘date‘ $1 Shell Issued " >> $lklogfile  #debug
        return                # done, command in
    else                      # variable "next_shell"
    echo "‘date‘ $1 Lock FAULTED $$" >> $lklogfile # debug
    fi                        # double check faulted
#   else                      # locked by other
#   echo "‘date‘ $1 Lock Wait $$" >> $lklogfile # debug
    fi                        #
    sleep 1                   # brief pause
done                          # try again
return                        # only if no commands
}
```

```
#-------------------------------------------------------------
# paresh_slave
#   This code is executed by each of the slaves. It basically
#   requests a command, executes it, and returns the status.
#-------------------------------------------------------------
#
paresh_slave()
{
shell_count=0                # Commands done by this slave
get_shell $1                 # get next command to execute
while test "$next_shell" != ""
                             # if no command, all done
do                           # got a command
    shell_count=‘expr $shell_count + 1‘
                             # increment counter
    message "Slave $1: Running  Shell $next_shell"
                             # message
    $next_shell              # execute command
    shell_status=$?          # get exit status
    if [ "$shell_status" -gt 0 ]
                             # on error
    then                     # then message
    message "Slave $1: ERROR IN Shell $next_shell
status=$shell_status"
    echo "Slave $1: ERROR IN Shell $next_shell
status=$shell_status" >> $errfile
    fi                       #
#   message "Slave $1: Finished Shell $next_shell"
                             # message
    get_shell $1             # get next command
done                         # all done
message "Slave $1: Done (Executed $shell_count Shells)"
                             # message
return                       # slave complete
}
```

```
# paresh_driver
#   This code is executed by the top level process only. It
#   parses the arguments and spawns the appropriate number
#   of slaves.  Note that the slaves run this same shell file,
#   but the slaves execute different code, based on the
#   exported variable PARESH.
#-----------------------------------------------------------------
#
paresh_driver()
{
rm -f $lklogfile                # start a new log file
if [ "$1" = "" ]                # first argument?
then                            # no?
    master_file="master.list"   # default value
else                            # yes?
    if [ ! -f "$1" ]            # does file exist?
    then                        # no?
    echo "$0: Unable to find File $1"
                                # say so
    exit 1                      # quit
    else                        # yes?
    master_file="$1"            # use specified filename
    fi
fi
if [ "$2" = "" ]                # Second Argument?
then                            # no?
    parallel_count=4# default value
else                            # Yes?
    if [ "$2" -lt 1 ]           # Less than 1?
    then                        # Yes?
    echo "$0: Parallel Process Count Must be > 0"
                                # message
    exit 1                      # quit
    else                        # no?
    parallel_count=$2           # Use Specified Count
    fi
fi
```

```
message "------------------------------"    # Startup Banner
message "Master Process ID:  $PARESH"
message "Processing File:    $master_file"
message "Parallel Count:     $parallel_count"
message "Log File:           $logfile"
message "------------------------------"
cp $master_file $workfile        # make a copy of commands file
while test  $parallel_count -gt 0# Have we started all slaves?
do                               # Not yet
    if [ ! -s $workfile ]        # Is there work to do?
    then                         # No?
    message "All Work Completed - Stopped Spawning at
$parallel_count"
    break                        # Quit spawning
    fi
    $0 $parallel_count &# spawn a slave (with slave #)
    message "Spawned Slave $parallel_count  [pid $!]"
                                 # message
    parallel_count=‘expr $parallel_count - 1‘
                                 # decrement counter
done                             # Next
wait                             # Wait for all slaves
message "All Done"               # message
return                           # Function Complete
}
```

```
#-------------------------------------------------------------
# main
#   This is the main section of the program. Because this shell
#   file calls itself, it uses a variable to establish whether or
#   not it is in Driver Mode or Slave Mode.
#-------------------------------------------------------------
#
if [ "$PARESH" != "" ]# If variable is set
then                                  # then slave mode
    workfile=/tmp/paresh.work.$PARESH# Work file with parent pid
    lockfile=/tmp/paresh.lock.$PARESH# Lock file with parent pid
    lklogfile=/tmp/paresh.lklog.$PARESH
                                      # LockLog file with
                                      # parent pid
    logfile=/tmp/paresh.log.$PARESH   # Log File with parent pid
    errfile=/tmp/paresh.err.$PARESH   # Error File with parent pid
    paresh_slave $*                   # Execute Slave Code
else                                  #
    PARESH="$$"; export PARESH        # Establish Parent pid
    workfile=/tmp/paresh.work.$PARESH# Work File with parent pid
    lockfile=/tmp/paresh.lock.$PARESH# Lock File with parent pid
    lklogfile=/tmp/paresh.lklog.$PARESH
                                      # LockLog File with
                                      # parent pid
    logfile=/tmp/paresh.log.$PARESH   # Log File with parent pid
    errfile=/tmp/paresh.err.$PARESH   # Error File with parent pid
    rm -f $errfile                    # remove error file
    paresh_driver $*                  # execute Driver Code
    rm -f $workfile                   # remove work file
    rm -f $lklogfile                  # remove lock log file
    if [ -f $errfile ]                # Is there was an error
    then
    message "************************************************"
    message "FINAL ERROR SUMMARY. Errors logged in $errfile"
    cat $errfile | tee -a $logfile
    message "************************************************"
    exit 1
    fi
fi
exit
```

Conclusion

In this article, a script is described that performs considerably fast Oracle database exports by using parallel processing on SMP machines. This script has been proven invaluable for situations where it is needed to perform exports of large mission-critical databases that must be highly available.

The script was contributed by its authors, Neal Sundberg and Mike Ellison of QUALCOMM Incorporated.

Author's Bio:

Stan Stringfellow is an independent author, technical writer and software developer who is currently doing work for the Sun BluePrints program. He holds a B.A.C.S. from UC San Diego and has written many manuals including the original softwre manuals for the Sun Enterprise 10000 (Starfire™). He may be contacted at stan@stringfellow.com.