

Database Consolidation Best Practices

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October 17, 2010



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Who am I ?

- Data&Information Expert on VLDB environments
 - DWH
 - Data Mining & Inference Systems
 - Data Archiving Solutions
 - Niche Storage Technologies
 - Recovery Strategies & Solutions
 - HA Systems
- Oracle ACED on BI Field
 - Only one in Turkey
 - Still the youngest one all over the community.
- DBA of the Year 2009
 - 7th and still the youngest one all over the community.
- Blogger @ <http://husnusensoy.wordpress.com>
- Member of Oracle CAB for 12g DWH development
- Worldwide presenter of Oracle conferences & user group events



What is it all about ?

- All those fancy names actually refer to same basic concept token as *Grid Computing*.
- There exists petabyte size clusters used for scientific researches for years, such as  PetaShare
- By the beginning of 1990s, academy has made the first move for non-local grids.
- Finally after 2005 (even before), commerce was also ready to GO !!!



Cloud Computing



Virtualization



Consolidation

Why to bother ?

- Top 3 IT Trends for 2009 and 2010:
 - 1 Software as a Service (Cloud Computing)
 - 2 Virtualization
 - 3 Energy-Efficient Data Centers



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 - 1 Software as a Service (Cloud Computing)
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 - 3 Energy-Efficient Data Centers
- Top 5 Priorities of CIOs
 - 1 Business productivity and cost reduction
 - 2 IT/Business alignment
 - 3 Agility and speed to market
 - 4 IT cost reduction
 - 5 IT reliability and efficiency



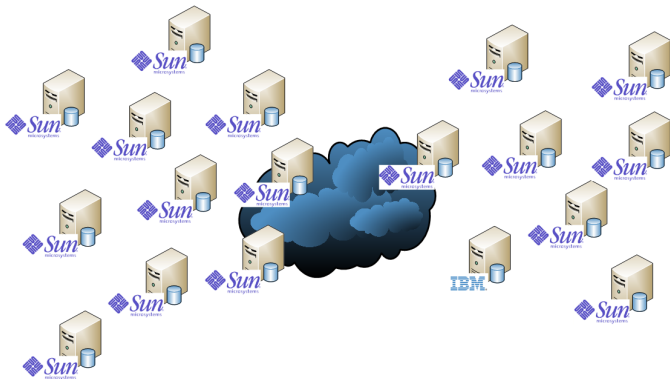
Database Consolidation in a Large Telco

- A recent research by an IT consultancy company shows that one of the largest Telcos of Europe has a data center utilization below 20% on the average. When we think some major systems, such as data warehouse, run over 80% utilization on the average, this statistics means some servers are completely idle.
- Some DBAs in VAS database team were under extreme load. DB to DBA ratio was around 10-15 on the average.
- Yearly OPEX of SMP machines have already started to be a pain in the neck.
- Majority of databases were running on single instance architecture which always endangers our availability.



From Customer's Perspective

Before Consolidation

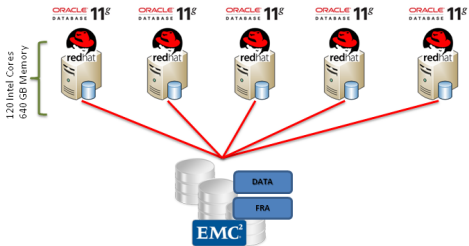
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After Consolidation



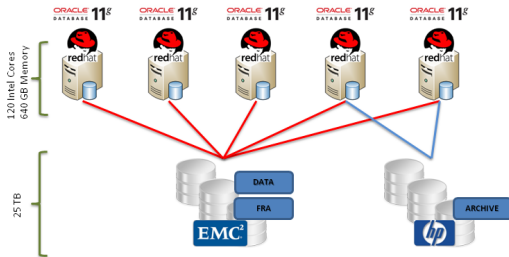
From Customer's Perspective

After Consolidation



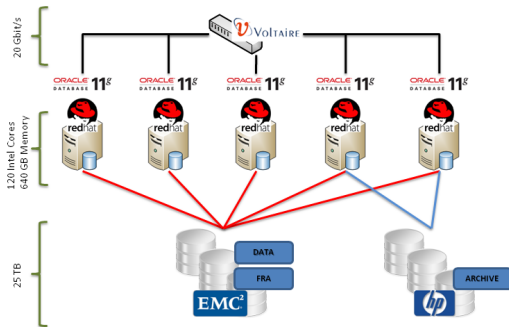
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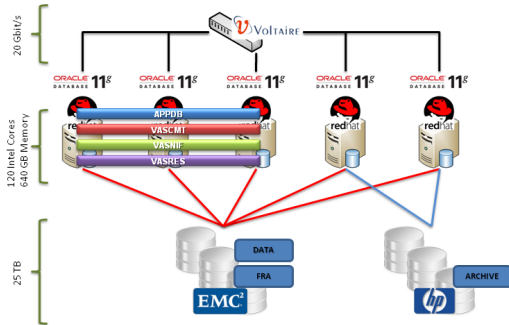
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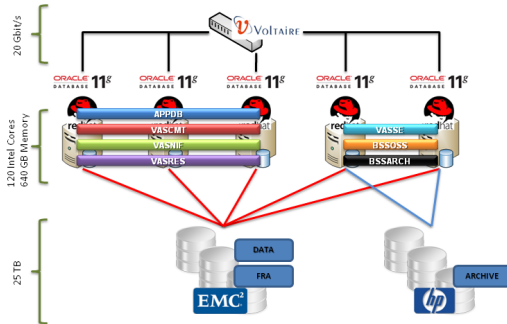
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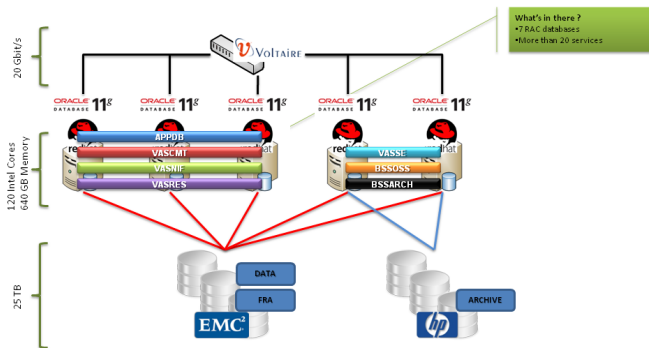
From Customer's Perspective

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From Customer's Perspective

After Consolidation



Choosing Candidates to Consolidate

Nobody can give you a silver bullet about this because it is all about your company's need(s). You should first define your goal(s).

Why do you consolidate ?

- just to see whether we can
- to increase average server processing,I/O,memory,network,etc. utilization
- to move from SMP machines to commodity hardware
- to renew technology
- to consolidate our data centers
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🏠 Real Life

Here are our criterias to choose candidates

- Server processor utilization
- Data Center location
- Application and vendor limitations (version dependencies)
- Dependencies with other systems
- Business streams
- Risk level
- I/O characteristics



Choosing Candidates to Consolidate

After defining your reason(s), if your reason(s) requires the collection of system metrics to define right candidates, you need a repository that contains this data. Never skip this step because this is very crucial for



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🏠 Real Life

We had 3 data centers and 100s of database hosts. It takes 3 weeks for us to complete all grid agent installations on missing servers. So keep in mind that for large data centers this task may not be trivial.

We have used Oracle Grid Control repository for CPU and memory metrics and EMC ECC to gather host based disk I/O metrics.



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You can now choose a superset of candidate list satisfying your requirements. Next step will be to fine-tune the list by performing one-to-one meetings with the DBAs of those systems to ensure nothing is wrong for the consolidation of candidate database.



Initial Hardware Capacity Planning

After preparing your final candidate list, next step will be to do a initial capacity planing.

- How many cores, HBAs,etc ?
- What type of interconnect and what capacity ?

Remember that consolidation environment is built to be flexible and horizontal scalable. So you will do only an initial capacity planning. In the next phases of environment you will be adding more building blocks (identical nodes) to your grid.



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- Some components are correlated with each other in commercial hardware, such as CPU cores and memory. So usually it will be sufficient to compute one of them.
- Always put a 10%-20% error rate for any computation you made.



Start with capacity planning for CPU

- If your team is not very experienced with Oracle RAC, choose larger machines if possible. For example, instead of 6x8 core Intel machines use 2x24 core Intel machines. Fewer nodes mean simpler grid architecture.
- Use physical cores for Intel, AMD, and old Sun SPARC processors and physical thread numbers for new SPARC cores. Be careful about IBM processors. Their core architectures are design to be faster than other commercial cores. So assume each IBM core as 2 times faster than an Intel/AMD/SPARC core/thread (not valid for Nehalem)



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- Build a time-based (more granular is better) table of candidate servers' maximum (worst case analysis) CPU utilizations covering last 1-3 months:

TStamp	S1 (16 UltraSparc)	S2 (8 IBM)	S3 (32 Intel)	Total Intel Need
00:00	100%	40%	20%	$16 \times 1 + 8 \times 2 \times 0.4 + 32 \times 0.2 = 28.8$
00:05	80%	30%	100%	49.6
00:10	10%	10%	40%	16
00:15	40%	50%	50%	30.4



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00:15	40%	50%	50%	30.4

- In this toy example the CPU need is 55 Intel cores (with 10% error margin). So if your choices are 8,16,24,32 core machines you will start with a 7,4,3, or 2 node RAC implementation.



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- One thing to ensure for your cluster is that sum of candidate database hosts' memory (plus 10%) should be less than equal to your grid total memory size.



Disk Storage Capacity Planing

Storage requirement has two components

- 1 Storage area size including RAID,spare,etc
- 2 Throughput



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- Do not mix sequential large I/O load databases (DSS) with the small low latency random I/O demanding ones (OLTP).
- Ensure that all databases dominated by small random I/O you are consolidating have an average I/O response time below 10ms on the average and 20ms at max.
- Keep in mind that no hardware will deliver its spec value in real life. Practically you will get an effective value which is 70%-80% of spec value (For a 4 Gbit HBA your practical throughput average will be 280-320 MB/s at peak).
- If you are consolidating OLTP environments 3 HBAs per node will be sufficient (2 HBA for SAN storage and 1 for backup SAN)



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Storage size capacity planing

- If you like to use Incrementally Updated Backup strategy, which I strongly recommend, remember to double (indeed slightly more) your storage requirement.



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Any capacity plan may fail due to various reasons. Such as, assumptions, hardware spec errors, configuration errors, etc. You should ensure that your capacity planning is correct. This is made up of two steps :



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Benchmark/Stress testing tools are your best friends, such as

▶ [ORION](#) for disk I/O , ▶ [uiperf](#) for network, or ▶ [rds-stress](#) for RDSolB.



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Real Life

In our grid, we require 8000 IOPS with a latency of 10ms on the average. In order to deliver this value, our storage administrator has changed the SAN configuration 6 times. Without verification process there is no way to catch it.

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Real Life

For validation, here is the steps we followed in our project:

- 1 Capture the load in candidate databases (18 10g databases) between time T1-T2.
- 2 Perform a point in time recovery of those databases on grid (T1)
- 3 Simultaneously start all 18 replays over cluster.
- 4 Check for AWR reports of all 18 databases for any problem.

Seperate OS Users

In a consolidated database environment separation of roles gain more importance.

- Do you want a DBA of a DB on cluster to shut down ASM instance on one of the nodes causing all other DB instances to shut down?
- Do you want a DBA to shut down the listener of a DB he/she is not responsible with on the cluster.
- Do you want an interim patch/patchset to be applied to affect all databases at a time ?

Not to face with outcomes of those scenarios, separating required OS users,groups and ORACLE_HOME directories are essential



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🏠 Real Life

Here is the list of Oracle related users of our cluster

User	Primary Group	Other Groups	ORACLE_HOME
crs	oinstall	dba*,asmadmin	/u01/app/crs/product/11.1.0
oracle	oinstall	dba,oper,dbasm	/u01/app/grid/product/10.2.0/agent10g
asm	oinstall	dba*,asmadmin,oper	/u01/app/asm/product/11.1.0
vasres	oinstall	dba1,oper1,dbasm	/u02/app/oracle/product/11.1.0
vascmt	oinstall	dba2,oper2,dbasm	/u03/app/oracle/product/11.1.0
appdb	oinstall	dba3,oper3,dbasm	/u05/app/oracle/product/11.1.0

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You should check the expected behaviour of your grid in case that following events occur before going to production

- Node/Instance/ASM Instance/Listener Failure
- CRS process failure
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Real Life

Me & system architect of the project spent 6 hours in our system room to complete all tests comprehensively.



MEMORY_TARGET vs SGA_TARGET

- If the memory of a single node is pretty high in your grid then default memory page size (4K in 2.6) cause millions of memory pages to be managed by OS kernel(TLB management) which in return increases kernel CPU utilization. This problem can be bypassed by the use of huge pages in Linux.



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Real Life

We have set 20000 (40GB) huge pages per node on our grid. This decreases the number of allocated memory pages from 32 M to 64K. Monitor your huge page status by

```
# cat /proc/meminfo | grep Huge
HugePages_Total: 20000
HugePages_Free: 10131
HugePages_Rsvd: 2538
Hugepagesize: 2048 kB
```



How much to overlap ?

Oracle supports multiple instances to overlap over a single node, just like in our architecture. In theory there is no limit for the number of instances to be overlapped over a node as long as there are sufficient resources.

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Real-time Oracle Processes There are critical Oracle processes like LMSn which run in real-time priority. Those processes use the benefit of pre-emptive capabilities of OS process scheduler to use CPU whenever they like. However if the number of cores are less than the total number of real-time processes then you will be damaging the real-time behaviour of those processes.



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Management Difficulties Oracle does not provide a mechanism to consolidate AWR,ASH,etc reports of separate instances on the same node. In case of a problem you should manually understand which DB is the source of problem by looking each and every report manually.



Install ORACLE_HOME to all nodes

- For various benefits like rolling patching, use non-shared Oracle Home architecture in your grid.
- Due to some space considerations, you might wish to install RDBMS ORACLE_HOMEs just to the nodes on which member instances will run. However installing all RDBMS homes on all nodes have various benefits.



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Advantages

- 1 It will give you the flexibility to move any database to any node you like on the grid immediately (you will not be waiting for the storage to be provisioned for new ORACLE_HOME instance).
- 2 Remember that, simple architectures are the best ones. By installing everything to everywhere you will obtain a homogeneous view in your cluster which certainly ease grid management.



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Disadvantages

- 1 You will need an extra storage (around 2.5-3GB) for each new home you install.
- 2 Installation/Upgrade tasks will take slightly more time because you have more homes to be install/patched.



OS Level Monitoring

- OS level system statistics gathering is extremely important in a grid system because of overlapping database instances.
- Another importance of OS level statistics are that they are the guidelines of your future capacity planning.
- OSWatcher 3.0 is one the best options you can take (Latest version also gathers [▶ IB](#) and [▶ RDS](#) statistics).



Red Hat Linux vs Oracle Enterprise Linux

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- What makes difference is the support you get (Red Hat Support or Unbreakable Oracle Support).
- Both support teams are good only if you have a direct access. But keep in mind that in many countries, as in Turkey, you get Red Hat Linux support over hardware vendor which might be very ineffective.



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- Remember that working with minimum number of vendors will really increase your solution speed in case of a problem.



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- Set PROCESSES parameter for ASM instances above 100 because you will have more than one database served by them.
- Yet another important issue is the provisioning of diskgroups to grid nodes. If your configuration consists of more than one storage tier, you might wish to isolate some diskgroups from some nodes. You can do this by simply setting ASM_DISKGROUPS parameter at instance level.



ASM Configuration

- Without any doubt ASM is your practically only option for such a cluster because of its tight integration with CRS, and many management benefits.
- Create your ASM diskgroups explicitly with compatibility level 11.1 to get the benefits like variable extent sizing. If you don't specify anything, ASM will create with compatibility 10.2 by default in 11g Release 1.
- Set PROCESSES parameter for ASM instances above 100 because you will have more than one database served by them.
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🔗 Real Life

Here is the ASM instance configuration in our grid configuration

	+ASM1	+ASM2	+ASM3	+ASM4	+ASM5
processes	200	200	200	200	200
asm_diskgroups	DATA,FRA	DATA,FRA	DATA,FRA	ARCHIVE,FRA	ARCHIVE,FRA

Backup & Recovery Strategy

Backup & Recovery best practices of such a grid requires a dedicated presentation.

Real Life

Just to stress how important it is, as the DB architect of the system, B&R guide was the first document I have written throughout the project.

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For more details refer my presentation with Tim Chien in Open World 2009 [▶ Backup & Recovery Best Practices in 11g](#)



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Advantages

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- 2 Decreasing the number of individual databases will reduce your administrative costs (less backup, performance tuning, etc)
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Disadvantages

- 1 Merge operation is usually not a trivial one. You should deal with parameter file merge, conflict management, etc.
- 2 You should scan all your application domain and may need to synchronize some applications with the new architecture, for example schema name changes.

How to Migrate ?

Oracle gives many tools to be used for migration of a database, such as

- Transportable Tablespaces
- Physical/Logical Standby
- Even DB Link

When we look the consolidation migration nature for a few TB (upto 5-6 TB) databases use Data Pump (in parallel) definitely



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Advantages

- 1 Platform difference management is transparent in data pump.
- 2 Version difference management is easy in data pump.
- 3 Data pump can run in parallel.
- 4 For schema conflict management data pump is the best option.
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Disadvantages

- 1 You will need an auxiliary storage to keep dmp files
- 2 Migration with data pump should be OFFLINE

Merge & Conflict Resolution

It is almost inevitable that some global database object will be conflicting during the database merge operation. Most common ones are

- Schemas and their items
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Fortunately, Data Pump REMAP feature will help you to handle schema conflicts by automatically renaming transferred schema

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REMAP_TABLESPACE is very useful to rename conflicting tablespace names of different databases.



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In our project, sum of SESSIONS parameter of 5 databases to be consolidated in a 3-node RAC was 7000. Instead of setting *.SESSIONS parameter (per instance) to 2300 (7000/3) we have chosen 3500 (7000/2) to ensure that we will not face any *ORA-00018: maximum number of sessions exceeded* error when we shutdown one RAC instance.



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Setting some of those parameters require a modification at OS site also.

Real Life

There are 4 database instances (plus ASM instance) on a single node with 1700,2850,2200,3175 (200) PROCESSES parameters. In order to Linux to create and manage that many processes we have modified *kernel.sem* to an appropriate value:

```
# sysctl -w kernel.sem="5010 641280 5010 128"
```



Merge & Grouping Strategy

Real Life

We have merged 16 databases to 4 databases in our consolidation projects. And start each migrated database as preferred RAC service on three nodes. In grouping different databases the grouping strategy was based on business streams. Databases of similar VAS consolidated within same database.

Other Migration Best Practices

- Create all databases by following above best practices without starting any migration. This is crucial because most probably you will not be able to concentrate on fine details during migration chaos.
- Choose an incremental model for migration because
 - This will protect you in case that you hit a serious hardware/software problem.
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- Prioritize your migration. Start with non-critical candidates and end with critical ones.

AL-JOBAL
MAKSIMUM

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- Oracle is and keeping on investing database technologies targeting consolidation. Such as ASM, RAC services, and online compression.
- Some emerging technologies in the market like commodity hardware, Linux OS, and IB will help you to decrease your energy and licensing, and hardware costs dramatically.
- Only a well planned consolidation project can help you to reach your ultimate goal.



Q & A