

Oracle Database Performance Tuning: The Not SQL Option

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Introduction

Instructor



- Daniel Morgan
- 🏆 Oracle ACE Director
- More than 45 years technology experience
 - First computer was an IBM 360/40 mainframe in 1970
 - Fortran IV and Punch Cards
- 🏛 Curriculum author and primary Oracle instructor at University of Washington
- 🏛 Guest lecturer on Oracle at Harvard University
- Decades of hands-on SQL, PL/SQL, and DBA experience
- The "Morgan" behind Morgan's Library on the web
www.morganslibrary.org
- 10g, 11g, and 12c Beta tester
- Co-Founder Intl. GoldenGate Oracle Users Group
- Contact email: dmorgan@forsythe.com



My Websites: Morgan's Library



Morgan's Library

www library

Search

International Oracle Events 2015-2016 Calendar

Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

The Library

The library is a spam-free on-line resource with code demos for DBAs and Developers. If you would like to see new Oracle database functionality added to the library ... just email us. Oracle 12.1.0.2.0 has been released and new features will be showing up for many weeks. The first updates have already been made.

Home

Resources

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Presentations Map



MadDog Morgan



Training Events and Travels

- [IOUG, Chicago, Illinois - Mar 10](#)
- [UTOUG, Salt Lake City, Utah - Mar 11-12](#)
- [OUGN, Oslo, Norway - Mar 12-14](#)
- [Collaborate, Las Vegas, Nevada - Apr 12-16](#)
- [NYOUG, New York, NY - May 19](#)
- [GLOC, Cleveland, Ohio - May 19-20](#)

Next Event: 27 January, Redwood Shores, CA

Morgan



aboard USA-71



Library News

- [Morgan's Blog](#)
- [Join the Western Washington OUG](#)
- [Morgan's Oracle Podcast](#)
- [US Govt. Mil. STIGs \(Security Checklists\)](#)
- [Bryn Llewellyn's PL/SQL White Paper](#)
- [Bryn Llewellyn's Editioning White Paper](#)
- [Explain Plan White Paper](#)



Oracle Events



Click on the map to find an event near you

ACE News

Would you like to become an Oracle ACE? 📌

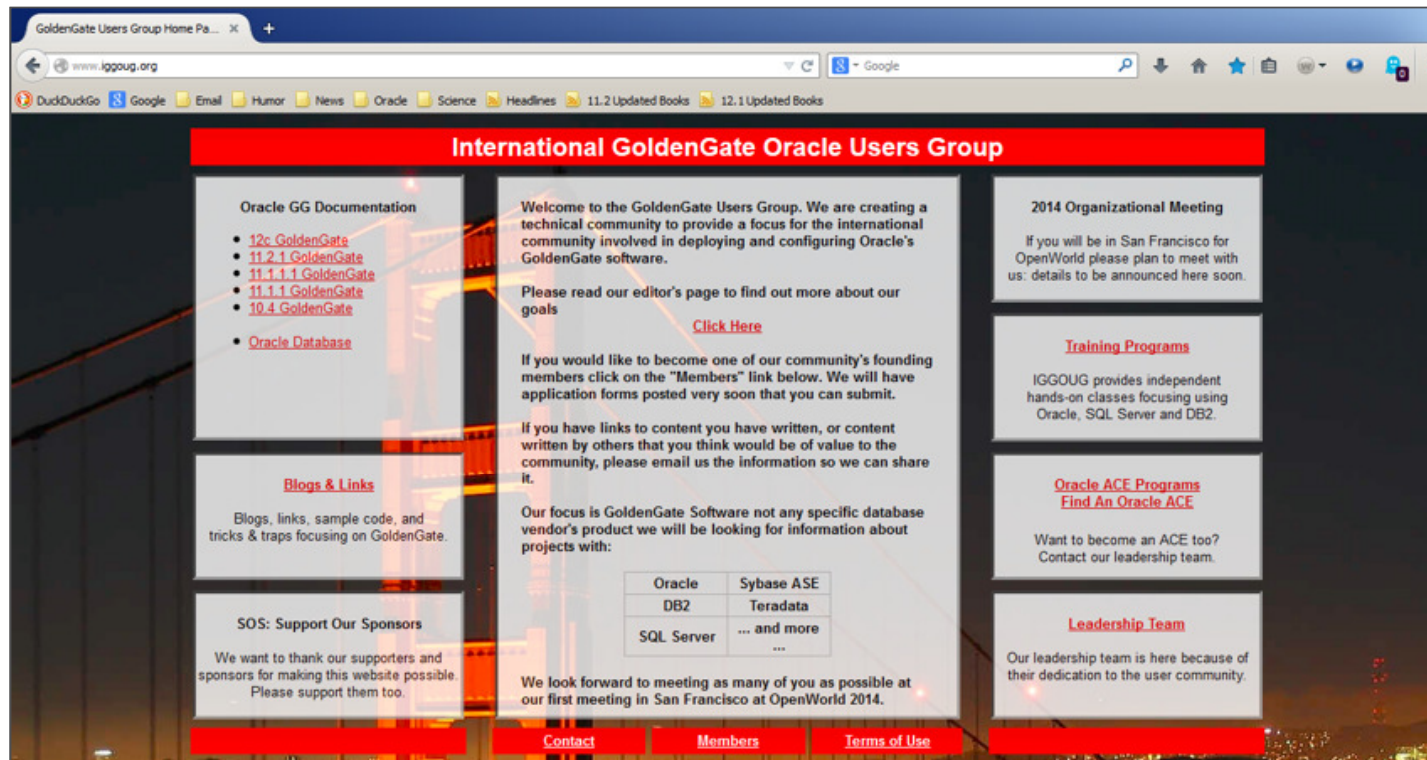
Learn more about becoming an ACE



- [ACE Directory](#)
- [ACE Google Map](#)
- [ACE Program](#)
- [Stanley's Blog](#)

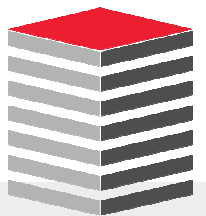
Congratulations to our newest ACE Director Jim Czuprynski

My Websites: International GoldenGate Oracle Users Group



Why Meta7

- The Oracle Only division of Forsythe dedicated to the Oracle Red Stack
 - Highly skilled consultants with extensive experience across multiple industries
 - Reliable on-time and on-budget delivery
 - A professional and agile team of Oracle technical experts
 - New, State of the Art Technology Evaluation Center
 - Secure hosting and Managed Services
 - Flexible financial support



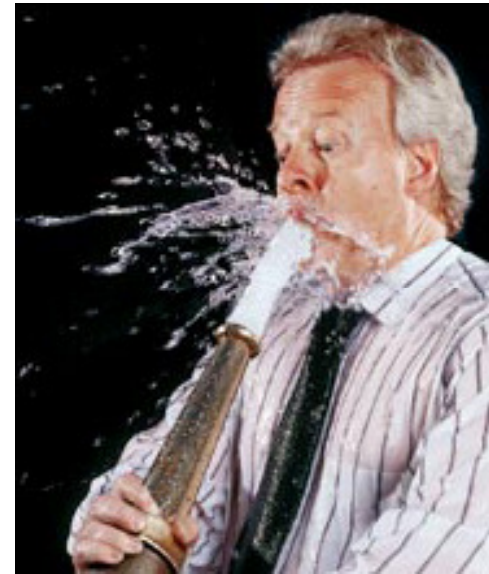
Travel Log: 2014



Content Density Warning



Take Notes ... Ask Questions



Mythology + Methodology

The #1 Database Performance Tuning Mythology

Instance Efficiency Percentages (Target 100%)

Buffer Nowait %:	99.80	Redo NoWait %:	100.00
Buffer Hit %:	97.34	In-memory Sort %:	99.99
Library Hit %:	99.97	Soft Parse %:	98.79
Execute to Parse %:	99.29	Latch Hit %:	99.57
Parse CPU to Parse Elapsd %:	0.00	% Non-Parse CPU:	96.60

This was from the worst performing Oracle Database I've seen since 2006

The #1 Database Performance Tuning Methodology

Guessing



BAAG Comrades

7-Sep-08	Mohammad Illiyaz http://	BAAG Member	Because i also want to BATTLE AGAINST ANY GUESSES
22-Sep-08	Ken Jordan http://	BAAG Member	Seeking THE truth!
27-Sep-08	Martin Berger http://berx.at	BAAG Member	I travel on a sea of wild guesses, with some islands of educated guesses. Knowledge is the stars which help me traveling on these seas. I need more light!
22-Nov-08	Daniel Morgan http://www.morganslibrary.org	BAAG Member	Too often a conclusion is simply the place where someone became tired of thinking. Then the "answer" becomes a guess, a prejudice, or a retreat to mythology. I prefer the application of synapses.
11-Feb-09	Fairlie Rego http://www.el-caro.blogspot.com	BAAG Member	becoz I have had enuff
3-Mar-09	Olivier NOEL http://	BAAG Member	Help me in my daily struggle against Oracle
16-Mar-09	Michael Erwin http://www.oracle.com/consulting/technology/gnid-computing.html	BAAG Member	I like sharing what I know as actual fact vs. guessing as well.
18-Mar-09	Randolf Geist http://oracle-randolf.blogspot.com/	BAAG Member	I guess (!) it's time to join.
1-Apr-09	Kevin Fries http://	BAAG Member	I guess it cannot make things worse, I've tried everything else and the Magic 8-Ball broke.
13-Apr-09	Henrik Harsfort http://	BAAG Member	to guess is to not know.
24-Apr-09	Paul Clare http://	BAAG Member	Creative problem solving is evolving into an art form.



BAAG Membership



Christian Antognini
 Karl Arao
 Mark Bobak
 Ronald Bradford
 Wolfgang Breitling
 Doug Burns
 Andrew Clarke
 Randolph Geist
 Alex Gorbachev
 Marco Gralike
 Frits Hoogland
 John Hurley
 Anjo Kolk
 David Kurtz
 Jonathan Lewis
 Robyn Sands
 Jared Still
 Jeremiah Wilton

BAAG Comrades

BAAG Party - Battle Against Any Guess

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Recent Posts

- [The Statspack for PostgreSQL — Meet Pgstatspack](#)
- [SQL Server Performance Diagnostic — Still Guessing?](#)
- [Welcome ASH Masters!](#)
- [BAAG Members page change](#)
- [Avoiding Guesswork in Complex Environments](#)

Recent Comments

- [Alex Gorbachev on Avoiding Guesswork in Complex Environments](#)
- [Graham Oakes on Avoiding Guesswork in Complex](#)

About BAAG

Battle Against Any Guess

BAAG - what is it all about? The main idea is to eliminate guesswork from our decision making process — once and for all. It's not Oracle specific even though the roots lie in the area of Oracle database administration. So keep reading even if you don't know anything about Oracle or computers. Before we go any further I should say that the title was inspired by another fine BAA... site — [BAARF](#). Just to avoid any guesses. 😊

After some mental fermentation the [birth](#) of BAAG had been finally triggered by an Oracle-L [thread](#) started as [10gR2 performance sux](#). Title of the post was a direct consequence of pure guess and, worse yet, uneducated guess. It's also interesting to see how the thread [developed](#) - guesswork. [Another problem](#) in the same thread was followed up by the same troubleshooting style. Perhaps, the author, inspired by previous responses, also hoped to find the magic solution from of Oracle-L powered (and often educated) guesses.

Database performance tuning is one of the most noticeable areas where guesswork is still flourishing. There were quite a few methodological techniques born recently, such as [YAPP](#) and [Method R](#), and older guess-based methods such as [Tuning by BCHR](#) are going away. Nevertheless, people's mentality is very difficult to change and we keep relying on guesswork hoping to solve the issue faster. Hope-powered guess is the evil.

Performance tuning is just one example. Imagine that your Oracle database crushes with ORA-600 and guesswork starts powered by your experience. Depending how good your memory and experience are you might want to ask in an Oracle forum something like "My database x.x.x.x crashed with ORA-600. Anyone seen it?" It's fishing for a

MySQL

- [Baron Schwartz](#)
- [Peter Zaitsev](#)
- [Pythian Blog \(MySQL\)](#)

Oracle

- [Anjo Kolk](#)
- [ASH Masters](#)
- [Cary Millsap](#)
- [Daniel Fink](#)
- [James Morie](#)
- [Jonathan Lewis](#)
- [Mogens Nergaard](#)
- [Niall Litchfield](#)
- [Pythian Blog \(Oracle\)](#)
- [Tanel Poder](#)
- [Tom Kyte](#)

PostgreSQL

- [Statspack](#)

Clearly

- No surprise ... I do not endorse guessing
- Possibly a big surprise ... I do not like normal AWR reports
- I think the solutions to every performance issue is an Exadata
- And I am not attracted to all the tools with pretty GUIs
- So let us take a deep dive into performance tuning and address the root cause of the majority of issues I see in my work
- We will focus on what fixes all issues ... not just one issue
- We all know that 30+ years of doing it the way we have been
 - DBMS_SUPPORT introduced with version 7.2
 - DBMS_TRACE introduced with version 8.1.5
 - DBMS_MONITOR introduced with version 10.1
 - 10053 and 10046 traces and TKPROFhas not eliminated tuning problems

What Affects Performance

- Hardware
 - Servers Resources
 - CPU
 - Memory
 - Bus Bandwidth and Latency
 - Storage Subsystems
 - Networks
- Software
 - Operating System Configuration
 - Virtual Machines
 - Drivers
- Database
 - Memory Allocation
 - Optimizer Configuration
 - SQL Quality

- Application

- Web Servers
- Application Servers
- Middleware Caching
- Application Code Quality



Hardware

- Servers and Operating Systems
 - Blade Servers
 - I/O Cards
 - NUMA Architecture
 - HugePages
 - Swapiness
- Virtual Machines
- Storage
 - Controllers
 - Read-Write Caches
 - LUN Size and Layout
- Networks
 - TCP/IP
 - UDP



Blade Servers (1:2)

- Suitable for web and application servers
- Possibly usable for small databases
- A meltdown waiting to happen with RAC



RAC: Frequently Asked Questions (Doc ID 220970.1)

Cluster interconnect network separation can be satisfied either by using standalone, dedicated switches, which provide the highest degree of network isolation, or Virtual Local Area Networks defined on the Ethernet switch, which provide broadcast domain isolation between IP networks. VLANs are fully supported for Oracle Clusterware interconnect deployments. Partitioning the Ethernet switch with VLANs allows for:

- Sharing the same switch for private and public communication.
- Sharing the same switch for the private communication of more than one cluster.
- Sharing the same switch for private communication and shared storage access.

The following best practices should be followed:

The Cluster Interconnect VLAN must be on a non-routed IP subnet.

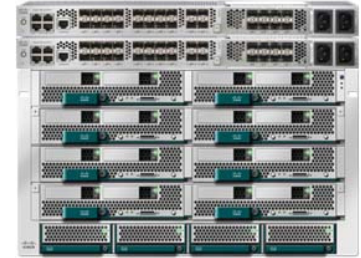
All Cluster Interconnect networks must be configured with non-routed IPs. The server-server communication should be single hop through the switch via the interconnect VLAN. There is no VLAN-VLAN communication.

Oracle recommends maintaining a 1:1 mapping of subnet to VLAN.

The most common VLAN deployments maintain a 1:1 mapping of subnet to VLAN. It is strongly recommended to avoid multi-subnet mapping to a single VLAN. Best practice recommends a single access VLAN port configured on the switch for the cluster interconnect VLAN. The server side network interface should have access to a single VLAN.

Blade Servers (2:2)

- Blade servers, of which Cisco UCS is but one example, do not have sufficient independent network cards to avoid the networking becoming a single point of failure
- It is good when the public interface has a "keep alive" enabled but this is a fatal flaw for the cluster interconnect as fail-over will be delayed
- When different types of packets, public, storage, and interconnect are mixed low-level diagnostics are difficult ... if not impossible
- When different types of packets, public, storage, and interconnect are mixed the latency of one is the latency of all
- Traffic from any one blade can impact all blades



Troubleshooting gc block lost and Poor Network Performance in a RAC Environment (Doc ID 563566.1)

6. Interconnect LAN non-dedicated

Description: **Shared public IP traffic and/or shared NAS IP traffic, configured on the interconnect LAN will result in degraded application performance, network congestion and, in extreme cases, global cache block loss.**

Action: **The interconnect/clusterware traffic should be on a dedicated LAN defined by a non-routed subnet.** Interconnect traffic should be isolated to the adjacent switch(es), e.g. interconnect traffic should not extend beyond the access layer switch(es) to which the links are attached. **The interconnect traffic should not be shared with public or NAS traffic.** If Virtual LANs (VLANs) are used, the interconnect should be on a single, dedicated VLAN mapped to a dedicated, non-routed subnet, which is isolated from public or NAS traffic.

I/O (1:3)

- Not all HBA cards are the same
- NIC cards vary widely in capabilities and performance
 - TCP/IP Off-loading
 - Kernel Optimization of the TCP/IP stack

```
--enable TCP kernel auto-tuning
/proc/sys/net/ipv4/tcp_moderate_rcvbuf (1=on)

-- tune TCP max memory: tune to 2xBDP (Bandwidth x Delay Product)
-- For example, with 40 Mbits/sec bandwidth, 25 msec delay,
-- BDP = (40 x 1000 / 8 Kbytes/sec) x (0.025 sec) ~ 128 Kbytes
/proc/sys/net/ipv4/tcp_rmem and tcp_wmem 4096 87380 174760

-- tune the socket buffer sizes by setting to 2xBDP
/proc/sys/net/core/rmem_max and wmem_max

-- ensure that TCP Performance features are enabled
/proc/sys/net/ipv4/tcp_sack
/proc/sys/net/ipv4/tcp_window_scaling
/proc/sys/net/ipv4/tcp_timestamps

-- additionally be sure NIC cards have TCP off-loading capability
```

- Optimize Data Guard

```
--sqlnet.ora
NAMES.DIRECTORY_PATH= (TNSNAMES, EZCONNECT)
DEFAULT_SDU_SIZE=32767

-- listener.ora
DGLOGSHIPB =
  (DESCRIPTION =
    (SDU = 32767)
    (SEND_BUF_SIZE=9375000)
    (RECV_BUF_SIZE=9375000)
    (ADDRESS_LIST =
      (ADDRESS = (PROTOCOL = TCP) (HOST =
10.0.7.2) (PORT = 1526))
    )
    (CONNECT_DATA =
      (SERVICE_NAME = prodb)
    )
  )
```

more examples: www.morganslibrary.org/reference/data_guard.html

- Optimize for RAC
 - Read the Oracle installation documents with very careful attention to the advice given for kernel parameters
 - If on Linux and you don't know what rmem and wmem are ... read the docs
 - If on Solaris and you don't know what rsize and wsize are ... read the docs?

NUMA Memory Allocation

- Non-Uniform Memory Access

- A memory design used in multiprocessing, where the memory access time depends on the memory location relative to the processor
- A processor can access its own local memory faster than non-local memory
- The benefits of NUMA are limited to particular workloads, notably on servers where the data are often associated strongly with certain tasks or users

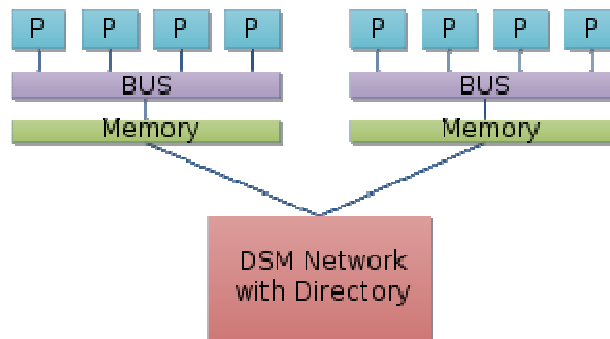


Diagram Source: Wikipedia

Detect NUMA Usage

```
[root@hclpl-oda01 etc]# numactl --hardware
```

```
available: 1 nodes (0)
```

```
node 0 size: 262086 MB
```

```
node 0 free: 113558 MB
```

```
node distances:
```

```
node    0
```

```
 0:    10
```

```
[root@hclpl-oda01 etc]# numactl --show
```

```
policy: default
```

```
preferred node: current
```

```
physcpubind: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41
```

```
42 43 44 45 46 47
```

```
cpubind: 0
```

```
nodebind: 0
```

```
membind: 0
```

NUMA Not Configured on an ODA

```
[dmorgan@lخورapln5 ~]$ numactl --hardware
```

```
available: 2 nodes (0-1)
```

```
node 0 size: 48457 MB
```

```
node 0 free: 269 MB
```

```
node 1 size: 48480 MB
```

```
node 1 free: 47 MB
```

```
node distances:
```

```
node    0    1
```

```
 0:    10    20
```

```
 1:    20    10
```

```
[dmorgan@lخورapln5 ~]$ numactl --show
```

```
policy: default
```

```
preferred node: current
```

```
physcpubind: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
```

```
cpubind: 0 1
```

```
nodebind: 0 1
```

```
membind: 0 1
```

NUMA Configured

Is Your Database NUMA Aware?

```
SQL> SELECT a.kspinm PNAME, c.kspstvl PVAL, a.kspdesc PDESC
2 FROM x$kspci a, x$kspcv b, x$kspsv c
3 WHERE a.indx = b.indx
4 AND a.indx = c.indx
5 AND LOWER(a.kspinm) LIKE '%numa%'
6* ORDER BY 1;
```

PNAME	PVAL	PDESC
-----	-----	-----

_NUMA_instance_mapping	Not specified	Set of nodes that this instance should run on
_NUMA_pool_size	Not specified	aggregate size in bytes of NUMA pool
_db_block_numa	1	Number of NUMA nodes
_enable_NUMA_interleave	TRUE	Enable NUMA interleave mode
_enable_NUMA_optimization	FALSE	Enable NUMA specific optimizations
<u>enable_NUMA_support</u>	<u>FALSE</u>	<u>Enable NUMA support and optimizations</u>
_numa_buffer_cache_stats	0	Configure NUMA buffer cache stats
_numa_shift_enabled	TRUE	Enable NUMA shift
_numa_shift_value	0	user defined value for numa nodes shift
_numa_trace_level	0	numa trace event
_px_numa_stealing_enabled	TRUE	enable/disable PQ granule stealing across NUMA nodes
_px_numa_support_enabled	FALSE	enable/disable PQ NUMA support
_rm_numa_sched_enable	FALSE	Is Resource Manager (RM) related NUMA scheduled
policy enabled		
_rm_numa_simulation_cpus	0	number of cpus for each pg for numa simulation in
resource mgr		
_rm_numa_simulation_pgs	0	number of PGs for numa simulation in resource manager

Enable Database NUMA Support

```
conn / as sysdba

ALTER SYSTEM SET "_enable_NUMA_support" = TRUE
COMMENT= 'NUMA Support Enabled 15-Mar-2015'
CONTAINER=ALL
SCOPE=SPFILE
SID='*';
```

HugePages

- Also known as "Large Memory Pages" or just "Large Pages"
- Each page table entry represents a “virtual to physical” translation of a process’s memory
- Can be as large as 64 KB in size per entry
- Can be huge for large memory systems
 - See PageTables in /proc/meminfo
 - As large as 1.5 GB
- The entire SGA must fit inside the HugePages
 - If it does not fit ... then none of it will use the HugePage memory
 - You will essentially have walled your database off from using a large portion of the server's memory

Swapiness

- Swapping (aka Paging)
- In a sense the operating system's version of the Oracle Temp tablespace

Value	Strategy
vm.swapiness=0	The kernel will swap only to avoid an out of memory condition
vm.swapiness=60	The default value
vm.swapiness=100	The kernel will swap aggressively

- In older versions of the ODA swapiness was set at 0 (a bad idea) and with the X5-2 has been set at 100 (an equally bad idea)

Virtual Machines

- Leave sufficient cpu resources for the bare-metal operating system to perform I/O and manage network traffic
- Disable interrupt coalescing
- Disable chipset power management
- Read the docs http://www.vmware.com/pdf/Perf_Best_Practices_vSphere5.0.pdf
- VMs on NUMA machines should be configured to enhance memory allocation
 - This example is from vSphere where 0 and 1 are the processor sockets

```
numa.nodeAffinity=0,1
```

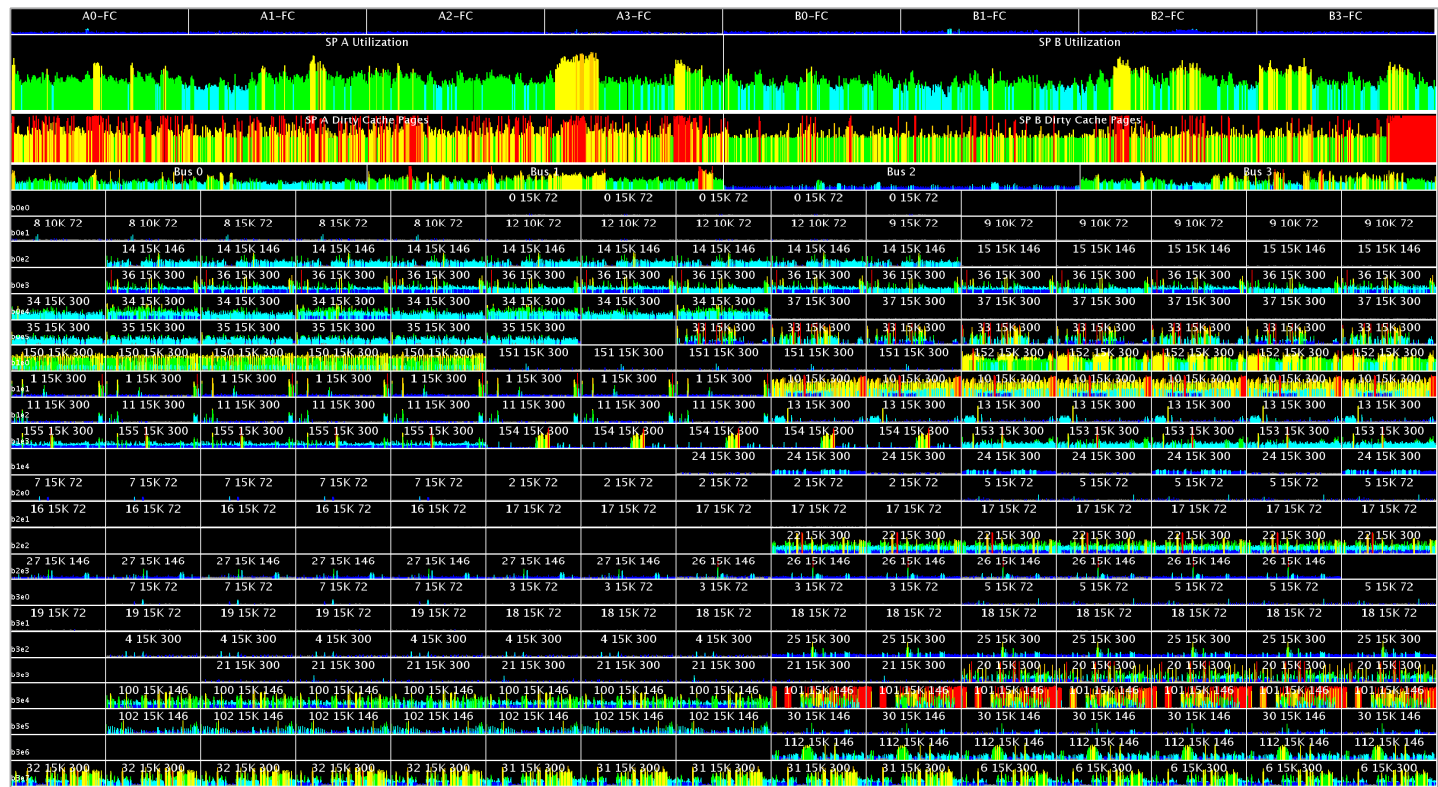
Storage Hardware

- Storage
 - Spinning Disk
 - Solid State Devices
 - Controllers
 - SAN Switches

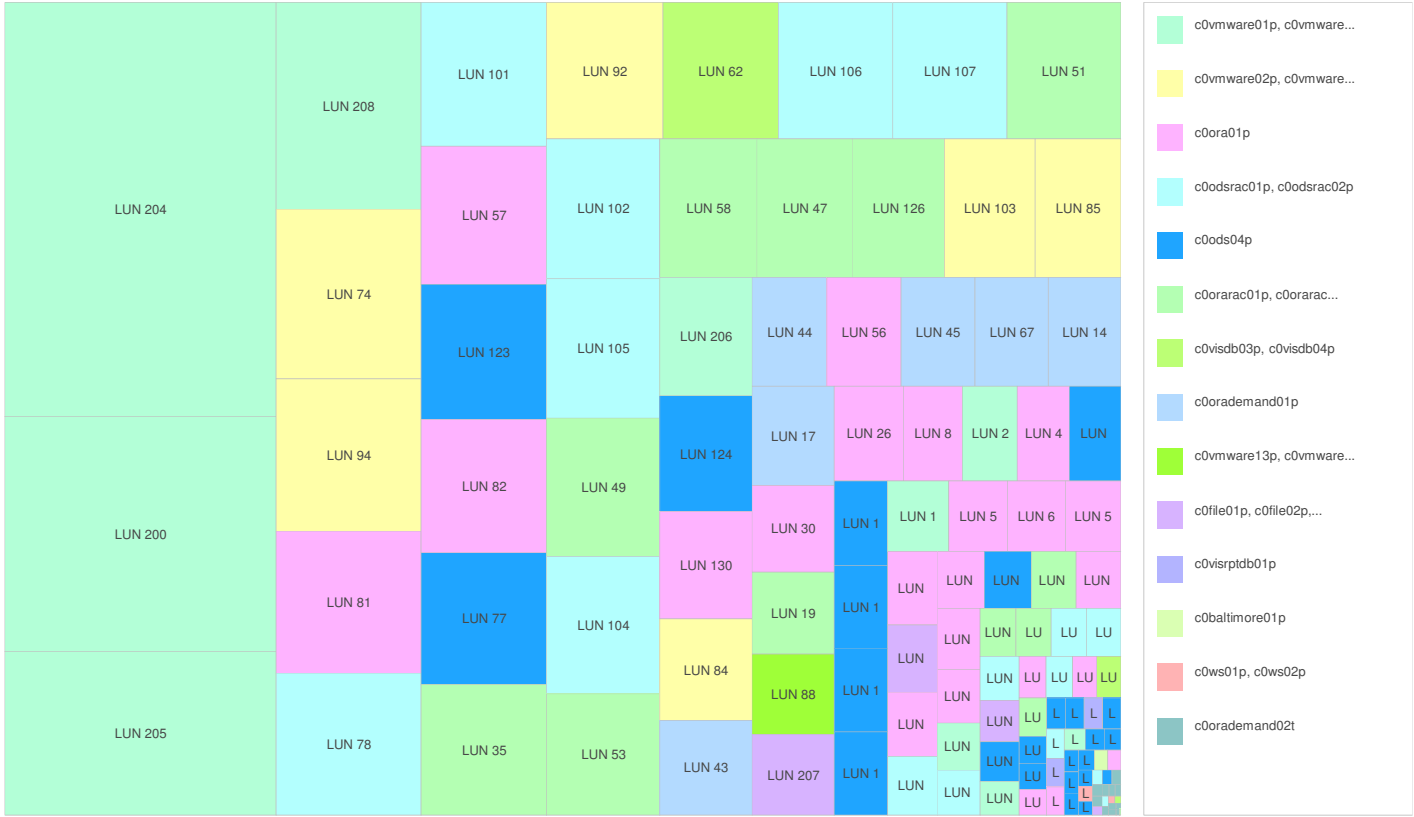
Device	Type	IOPS	Interface	Notes
7,200 rpm SATA drives	HDD	~75-100 IOPS ^[2]	SATA 3 Gbit/s	
10,000 rpm SATA drives	HDD	~125-150 IOPS ^[2]	SATA 3 Gbit/s	
10,000 rpm SAS drives	HDD	~140 IOPS ^[2]	SAS	
15,000 rpm SAS drives	HDD	~175-210 IOPS ^[2]	SAS	

Kaminario K2	Flash/DRAM /Hybrid SSD	Up to 1,200,000 IOPS SPC-1 IOPS with the K2-D (DRAM) ^{[41][42]}	FC	
NetApp FAS6240 cluster	Flash/Disk	1,261,145 SPECsfs2008 nfsv3 IOPs using 1,440 15K disks, across 60 shelves, with virtual storage tiering. ^[43]	NFS, CIFS, FC, FCoE, iSCSI	SPECsfs2008 is the latest version of the Standard Performance Evaluation Corporation benchmark suite measuring file server throughput and response time, providing a standardized method for comparing performance across different vendor platforms. http://www.spec.org/sfs2008/ .
Fusion-io ioDrive2	SSD	Up to 9,608,000 IOPS ^[44]	PCIe	Only via demonstration so far.

Storage Heat Map



Storage Layout

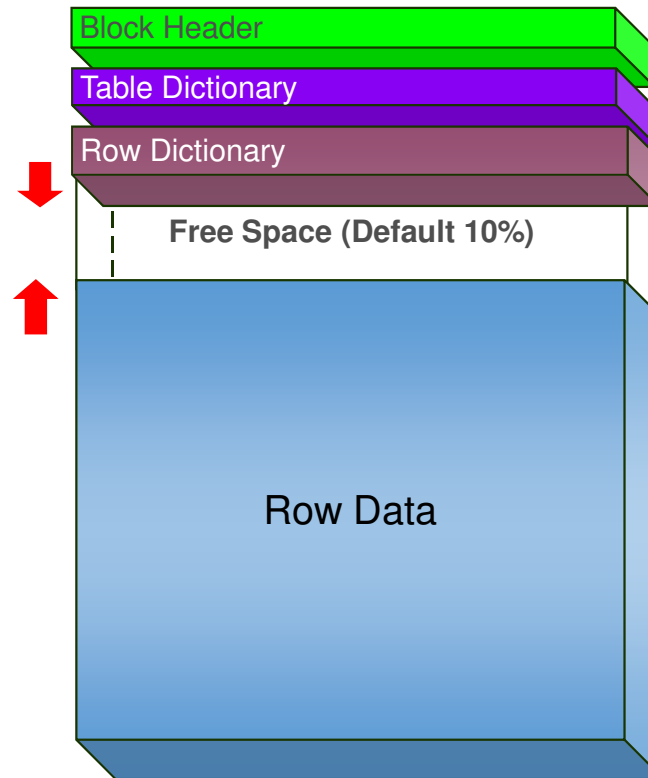


In-Object Space Wastage (1:6)

- By default the Oracle Database wastes 10% of all the storage you allocate to it

```
SQL> SELECT owner, pct_free, count(*)
2 FROM dba_tables
3 WHERE pct_free IS NOT NULL
3 GROUP BY owner, pct_free
4* ORDER BY 1,2;
```

OWNER	PCT_FREE	COUNT(*)
APEX_040200	0	2
APEX_040200	10	450
CTXSYS	0	16
CTXSYS	10	37
DBSNMP	0	1
DBSNMP	10	19
DVSYS	10	34
GSMADMIN_INTERNAL	0	5
GSMADMIN_INTERNAL	10	14
LBACSYS	10	22
MDSYS	10	130
ORDDATA	10	90
SYS	0	90
SYS	1	15
SYS	10	1105
SYSTEM	0	1
SYSTEM	10	131
WMSYS	0	16
WMSYS	10	24
XDB	10	28
XDB	99	1



-  General Block Information (Block add, Segment type) 85 ~ 100 bytes
-  Table info in Cluster
-  Row info in Block (2 byte per row)
-  Used when a row is inserted or updated (pctfree, pctused)
-  Table or Index Data

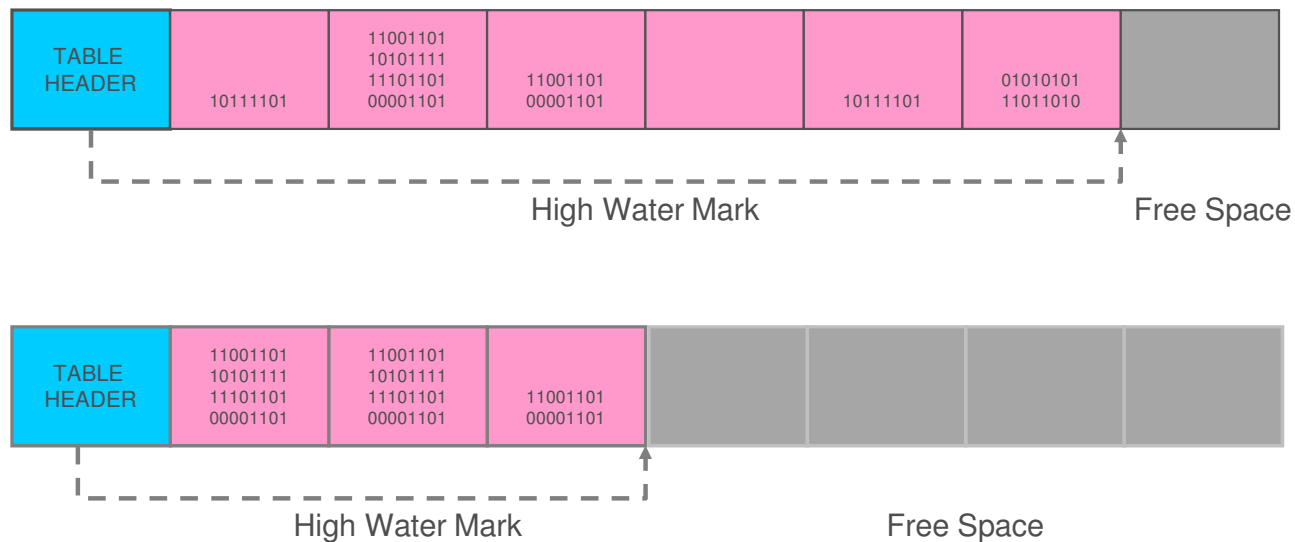
In-Object Space Wastage (2:6)

- Within file systems space may not be allocated efficiently to data files
- Within data files space may not be allocated efficiently to segments
- Within segment extents space may not be allocated efficiently too
- In the preceding example, assuming 10% free space and 90 rows per block
 - Reading 89 rows requires reading 8K
 - Reading 91 rows requires reading 16K
 - Without the pctfree loss reading 91-100 rows would still require only 8K of I/O
 - With the free space at 10% reading 200 rows requires reading 3 x 8K
 - With the free space at 0% reading 200 rows saves 1/3 of the I/O
- Know your systems well enough to know if you can eliminate the pct free value

In-Object Space Wastage (3:6)

- Online segments can be shrunk using a variety of technologies
 - DBMS_REDEFINITION
 - DBMS_SPACE
 - DDL

```
SQL> ALTER TABLE servers ENABLE ROW MOVEMENT;  
SQL> ALTER TABLE servers SHRINK SPACE CASCADE;
```



In-Object Space Wastage (4:6)

- DBMS_SPACE Built-In Package
 - Fully documented and supported
 - FREE_BLOCKS
 - SPACE_USAGE
 - UNUSED_SPACE
 - VERIFY_SHRINK_CANDIDATE
 - VERIFY_SHRINK_CANDIDATE_TBF

In-Object Space Wastage (5:6)

- No wastage

```
SQL> DECLARE
2  uf    NUMBER;
3  ub    NUMBER;
4  f1    NUMBER;
5  f1b   NUMBER;
6  f2    NUMBER;
7  f2b   NUMBER;
8  f3    NUMBER;
9  f3b   NUMBER;
10 f4    NUMBER;
11 f4b   NUMBER;
12 fbl   NUMBER;
13 fby   NUMBER;
14 BEGIN
15  dbms_space.space_usage('UWCLASS','SERVERS', 'TABLE', uf, ub, f1, f1b, f2, f2b, f3, f3b, f4, f4b, fbl, fby);
16
17  dbms_output.put_line('unformatted blocks: ' || TO_CHAR(uf));
18  dbms_output.put_line('unformatted bytes: ' || TO_CHAR(ub));
19  dbms_output.put_line('blocks 0-25% free: ' || TO_CHAR(f1));
20  dbms_output.put_line('bytes 0-25% free: ' || TO_CHAR(f1b));
21  dbms_output.put_line('blocks 25-50% free: ' || TO_CHAR(f2));
22  dbms_output.put_line('bytes 25-50% free: ' || TO_CHAR(f2b));
23  dbms_output.put_line('blocks 50-75% free: ' || TO_CHAR(f3));
24  dbms_output.put_line('bytes 50-75% free: ' || TO_CHAR(f3b));
25  dbms_output.put_line('blocks 75-100% free: ' || TO_CHAR(f4));
26  dbms_output.put_line('bytes 75-100% free: ' || TO_CHAR(f4b));
27  dbms_output.put_line('full blocks: ' || TO_CHAR(fbl));
28  dbms_output.put_line('full bytes: ' || TO_CHAR(fby));
29  END;
30  /
unformatted blocks: 0
unformatted bytes: 0
blocks 0-25% free: 0
bytes 0-25% free: 0
blocks 25-50% free: 0
bytes 25-50% free: 0
blocks 50-75% free: 0
bytes 50-75% free: 0
blocks 75-100% free: 0
bytes 75-100% free: 0
full blocks: 2
full bytes: 16384
```

In-Object Space Wastage (6:6)

- Minor wastage

```
SQL> DECLARE
2  uf    NUMBER;
3  ub    NUMBER;
4  f1    NUMBER;
5  f1b   NUMBER;
6  f2    NUMBER;
7  f2b   NUMBER;
8  f3    NUMBER;
9  f3b   NUMBER;
10 f4    NUMBER;
11 f4b   NUMBER;
12 fbl   NUMBER;
13 fby   NUMBER;
14 BEGIN
15   dbms_space.space_usage('XDB','X$QN40ORNNWS4T9IVANV2GK293AFHS', 'TABLE', uf, ub, f1, f1b, f2, f2b, f3, f3b, f4, f4b, fbl, fby);
16
17   dbms_output.put_line('unformatted blocks: ' || TO_CHAR(uf));
18   dbms_output.put_line('unformatted bytes: ' || TO_CHAR(ub));
19   dbms_output.put_line('blocks 0-25% free: ' || TO_CHAR(f1));
20   dbms_output.put_line('bytes 0-25% free: ' || TO_CHAR(f1b));
21   dbms_output.put_line('blocks 25-50% free: ' || TO_CHAR(f2));
22   dbms_output.put_line('bytes 25-50% free: ' || TO_CHAR(f2b));
23   dbms_output.put_line('blocks 50-75% free: ' || TO_CHAR(f3));
24   dbms_output.put_line('bytes 50-75% free: ' || TO_CHAR(f3b));
25   dbms_output.put_line('blocks 75-100% free: ' || TO_CHAR(f4));
26   dbms_output.put_line('bytes 75-100% free: ' || TO_CHAR(f4b));
27   dbms_output.put_line('full blocks: ' || TO_CHAR(fbl));
28   dbms_output.put_line('full bytes: ' || TO_CHAR(fby));
29 END;
30 /
unformatted blocks: 0
unformatted bytes: 0
blocks 0-25% free: 0
bytes 0-25% free: 0
blocks 25-50% free: 0
bytes 25-50% free: 0
blocks 50-75% free: 1
bytes 50-75% free: 8192
blocks 75-100% free: 2
bytes 75-100% free: 16384
full blocks: 2
full bytes: 16384
```

Other Object Optimizations

- Oracle's default tablespace settings waste disk and create unnecessary I/O
 - Often a smallfile tablespace is a bad choice
- Default table creations are almost always inefficient
 - Often heap tables are a bad choice
- Not every index should be a default B*Tree
 - And poor choices lead to poor performance
- Oracle sequence object defaults are almost always inefficient
 - A default cache size of 20 is a bad choice essentially all of the time
- The vast majority of PL/SQL I see written would have been valid in version 7.3.4
 - Constants declared as variables
 - Poor choices of data types
 - Non-use of FORALL syntax
- Oracle optimizes data dictionary performance by clustering tables ... do you?

I'm Not Afraid To Show You Mine



0c1p7vgy654kh

META7™ Solutions for the Red Stack

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```
when trunc(datetime_ins, 'mi') > trunc(sysdate)+7/24 then MSC end) summarised_late_count, count(distinct case when trunc(datetime_ins, 'mi') < trunc(sysdate)+7/24 then MSC end) summarised_online_count, sum(entries)
num_of_sumrows from NORTEL_PSCORE.VLR6_DY where datetime = trunc(sysdate)-1 )sumt union all SELECT 'NORTEL_PSCORE.GSCGMM' AS TABLENAME, sumday, CASE WHEN percent(summarised_online_count, (online_count-
late_count), 2) > 100 THEN 100 ELSE percent(summarised_online_count, (online_count-late_count), 2) END percent_of_cutoff, case when 100-percent(summarised_online_count, (online_count-late_count), 2) < 0 then 0 else
100-percent(summarised_online_count, (online_count-late_count), 2) end percent_of_cutoff_not_summed, percent(summarised_online_count, online_count+late_count, 2)percentage_of_total_by5am,
percent(summarised_online_count+summarised_late_count, online_count+late_count, 2) current_percentage, online_count+late_count current_raw_elements, summarised_online_count+summarised_late_count
current_summary_elements, summarised_online_count-summarised_late_count SUM_ELEMENTS_AT5AM, late_count late_raw_elements, online_count-late_count available_at_cutoff, percent(num_of_sumrows, num_of_rows, 2)
accuracy from ( select count(distinct case when trunc(datetime_ins, 'mi') > trunc(sysdate)+3/24 then SGSN end) late_count, count(distinct case when trunc(datetime_ins, 'mi') < trunc(sysdate)+3/24 then SGSN end) online_count, count
(*) num_of_rows from NORTEL_PSCORE.GSCGMM where datetime between trunc(sysdate)-1 and trunc(sysdate)-1/24.60 )rawt, ( select max(datetime)sumday, count(distinct case when trunc(datetime_ins, 'mi') > trunc(sysdate)+7/24
then SGSN end) summarised_late_count, count(distinct case when trunc(datetime_ins, 'mi') < trunc(sysdate)+7/24 then SGSN end) summarised_online_count, sum(entries) num_of_sumrows from NORTEL_PSCORE.GSCGMM_DY where
datetime = trunc(sysdate)-1 )sumt union all SELECT 'NORTEL_PSCORE.GSCSM_ACT' AS TABLENAME, sumday, CASE WHEN percent(summarised_online_count, (online_count-late_count), 2) > 100 THEN 100 ELSE
percent(summarised_online_count, (online_count-late_count), 2) END percent_of_cutoff, case when 100-percent(summarised_online_count, (online_count-late_count), 2) < 0 then 0 else 100-percent(summarised_online_count,
(online_count-late_count), 2) end percent_of_cutoff_not_summed, percent(summarised_online_count, online_count+late_count, 2)percentage_of_total_by5am, percent(summarised_online_count+summarised_late_count,
online_count+late_count, 2) current_percentage, online_count+late_count current_raw_elements, summarised_online_count+summarised_late_count current_summary_elements, summarised_online_count-summarised_late_count
SUM_ELEMENTS_AT5AM, late_count late_raw_elements, online_count-late_count available_at_cutoff, percent(num_of_sumrows, num_of_rows, 2) accuracy from ( select count(distinct case when trunc(datetime_ins, 'mi') >
trunc(sysdate)+3/24 then SGSN end) late_count, count(distinct case when trunc(datetime_ins, 'mi') < trunc(sysdate)+3/24 then SGSN end) online_count, count (*) num_of_rows from NORTEL_PSCORE.GSCSM_ACT where datetime
between trunc(sysdate)-1 and trunc(sysdate)-1/24.60 )rawt, ( select max(datetime)sumday, count(distinct case when trunc(datetime_ins, 'mi') > trunc(sysdate)+7/24 then SGSN end) summarised_late_count, count(distinct case when
trunc(datetime_ins, 'mi') < trunc(sysdate)+7/24 then SGSN end) summarised_online_count, sum(entries) num_of_sumrows from NORTEL_PSCORE.GSCSM_ACT_DY where datetime = trunc(sysdate)-1 )sumt union all SELECT
'NORTEL_PSCORE.GSCSM' AS TABLENAME, sumday, CASE WHEN percent(summarised_online_count, (online_count-late_count), 2) > 100 THEN 100 ELSE percent(summarised_online_count, (online_count-late_count), 2) END
percent_of_cutoff, case when 100-percent(summarised_online_count, (online_count-late_count), 2) < 0 then 0 else 100-percent(summarised_online_count, (online_count-late_count), 2) end percent_of_cutoff_not_summed,
percent(summarised_online_count, online_count+late_count, 2)percentage_of_total_by5am, percent(summarised_online_count+summarised_late_count, online_count+late_count, 2) current_percentage, online_count+late_count
current_raw_elements, summarised_online_count+summarised_late_count current_summary_elements, summarised_online_count-summarised_late_count SUM_ELEMENTS_AT5AM, late_count late_raw_elements, online_count-
late_count available_at_cutoff, percent(num_of_sumrows, num_of_rows, 2) accuracy from ( select count(distinct case when trunc(datetime_ins, 'mi') > trunc(sysdate)+3/24 then SGSN end) late_count, count(distinct case when
trunc(datetime_ins, 'mi') < trunc(sysdate)+3/24 then SGSN end) online_count, count (*) num_of_rows from NORTEL_PSCORE.GSCSM where datetime between trunc(sysdate)-1 and trunc(sysdate)-1/24.60 )rawt, ( select
max(datetime)sumday, count(distinct case when trunc(datetime_ins, 'mi') > trunc(sysdate)+7/24 then SGSN end) summarised_late_count, count(distinct case when trunc(datetime_ins, 'mi') < trunc(sysdate)+7/24 then SGSN end)
summarised_online_count, sum(entries) num_of_sumrows from NORTEL_PSCORE.GSCSM_DY where datetime = trunc(sysdate)-1 )sumt union all SELECT 'NORTEL_PSCORE.GSDSTATS' AS TABLENAME, sumday, CASE WHEN
percent(summarised_online_count, (online_count-late_count), 2) > 100 THEN 100 ELSE percent(summarised_online_count, (online_count-late_count), 2) END percent_of_cutoff, case when 100-percent(summarised_online_count,
(online_count-late_count), 2) < 0 then 0 else 100-percent(summarised_online_count, (online_count-late_count), 2) end percent_of_cutoff_not_summed, percent(summarised_online_count, online_count+late_count,
2)percentage_of_total_by5am, percent(summarised_online_count+summarised_late_count, online_count+late_count, 2) current_percentage, online_count+late_count current_raw_elements,
summarised_online_count+summarised_late_count current_summary_elements, summarised_online_count-summarised_late_count SUM_ELEMENTS_AT5AM, late_count late_raw_elements, online_count-late_count available_at_cutoff,
percent(num_of_sumrows, num_of_rows, 2) accuracy from ( select count(distinct case when trunc(datetime_ins, 'mi') > trunc(sysdate)+3/24 then SGSN end) late_count, count(distinct case when trunc(datetime_ins, 'mi') <
trunc(sysdate)+3/24 then SGSN end) online_count, count (*) num_of_rows from NORTEL_PSCORE.GSDSTATS where datetime between trunc(sysdate)-1 and trunc(sysdate)-1/24.60 )rawt, ( select max(datetime)sumday, count(distinct
case when trunc(datetime_ins, 'mi') > trunc(sysdate)+7/24 then SGSN end) summarised_late_count, count(distinct case when trunc(datetime_ins, 'mi') < trunc(sysdate)+7/24 then SGSN end) summarised_online_count, sum(entries)
num_of_sumrows from NORTEL_PSCORE.GSDSTATS_DY where datetime = trunc(sysdate)-1 )sumt
```

Optimizer Plans (1:4)

```
SELECT DISTINCT E1_2.OBJECT_ID
FROM PMCM.ELEMENT_DETAIL E1_1, PMCM.ELEMENT_DETAIL E1_2, PMCM.MARK_NETW_HIERARCHY H1,
PMCM.ELEMENT_DETAIL E2_1, PMCM.ELEMENT_DETAIL E2_2, PMCM.MARK_NETW_HIERARCHY H2
WHERE E1_1.OBJECT_ID = H1.PARENT_ID
AND E1_2.OBJECT_ID = H1.OBJECT_ID
AND E2_1.OBJECT_ID = H2.PARENT_ID
AND E2_2.OBJECT_ID = H2.OBJECT_ID
AND E1_1.CURRENT_IND = 'Y' AND E2_1.CURRENT_IND = 'Y'
AND E2_1.CURRENT_IND = 'Y' AND E2_2.CURRENT_IND = 'Y'
AND H1.CURRENT_IND = 'Y' AND H2.CURRENT_IND = 'Y'
AND H1.HIERARCHY_TYPE = 'NETWORK' AND H2.HIERARCHY_TYPE = 'NETWORK'
AND H1.PARENT_TYPE IN ('BSC','RNC') AND H2.PARENT_TYPE IN ('BSC','RNC')
AND E2_2.ELEMENT_TYPE = 'CELL' AND E1_2.ELEMENT_TYPE = 'CELL'
AND H1.PARENT_TYPE IN ('BSC','RNC')
AND E1_1.ELEMENT_NAME = E2_1.ELEMENT_NAME
AND E1_1.ELEMENT_ID = E2_1.ELEMENT_ID
AND E1_2.ELEMENT_NAME = E2_2.ELEMENT_NAME
AND E1_2.ELEMENT_ID = E2_2.ELEMENT_ID
AND E1_2.USEID LIKE '*%' AND E2_2.USEID NOT LIKE '*%';
```

	Id	Operation	Name	Rows	Bytes	TempSpc	Cost (%CPU)	Time	Pstart	Pstop
	0	SELECT STATEMENT		1	78		74M (40)	50:54:42		
	1	TEMP TABLE TRANSFORMATION								
	2	LOAD AS SELECT								
	3	PARTITION RANGE ALL		22M	1111M		38153 (11)	00:01:34	1	29
*	4	TABLE ACCESS FULL	ELEMENT_DETAIL	22M	1111M		38153 (11)	00:01:34		
	5	LOAD AS SELECT								
	6	PARTITION HASH ALL		337K	9231K		3514 (15)	00:00:09	1	16
*	7	TABLE ACCESS FULL	MARK_NETW_HIERARCHY	337K	9231K		3514 (15)	00:00:09		
	8	SORT AGGREGATE		1	78					
*	9	HASH JOIN		927G	65T	534M	74M (40)	50:53:00		
	10	VIEW		22M	277M		16808 (12)	00:00:42		
	11	TABLE ACCESS FULL	SYS_TEMP_OFDA7485F_6A66C42E	22M	1111M		16808 (12)	00:00:42		
*	12	HASH JOIN		21G	1272G	534M	1616K (43)	01:06:04		
	13	VIEW		22M	277M		16808 (12)	00:00:42		
	14	TABLE ACCESS FULL	SYS_TEMP_OFDA7485F_6A66C42E	22M	1111M		16808 (12)	00:00:42		
*	15	HASH JOIN		476M	23G	524M	97327 (22)	00:03:59		
*	16	HASH JOIN		10M	401M	8704K	34520 (10)	00:01:25		
*	17	HASH JOIN		234K	5948K	8256K	783 (10)	00:00:02		
	18	VIEW		337K	4286K		142 (14)	00:00:01		
	19	TABLE ACCESS FULL	SYS_TEMP_OFDA74860_6A66C42E	337K	3956K		142 (14)	00:00:01		
	20	VIEW		337K	4286K		142 (14)	00:00:01		
	21	TABLE ACCESS FULL	SYS_TEMP_OFDA74860_6A66C42E	337K	3956K		142 (14)	00:00:01		
	22	VIEW		22M	277M		16808 (12)	00:00:42		
	23	TABLE ACCESS FULL	SYS_TEMP_OFDA7485F_6A66C42E	22M	1111M		16808 (12)	00:00:42		
	24	VIEW		22M	277M		16808 (12)	00:00:42		
	25	TABLE ACCESS FULL	SYS_TEMP_OFDA7485F_6A66C42E	22M	1111M		16808 (12)	00:00:42		

Optimizer Plans (2:4)

Id	Operation	Name	Rows	Bytes	TempSpc	Cost (%CPU)	Time	Pstart	Pstop
0	SELECT STATEMENT		1	78		14T(100)	999:59:59		
1	TEMP TABLE TRANSFORMATION								
2	LOAD AS SELECT								
3	PARTITION RANGE ALL		22M	1111M		38153 (11)	00:01:34	1	29
* 4	TABLE ACCESS FULL	ELEMENT_DETAIL	22M	1111M		38153 (11)	00:01:34		
5	LOAD AS SELECT								
6	PARTITION HASH ALL		337K	9231K		3514 (15)	00:00:09	1	16
* 7	TABLE ACCESS FULL	MARK_NETW_HIERARCHY	337K	9231K		3514 (15)	00:00:09		
8	SORT AGGREGATE		1	78					
9	MERGE JOIN		471P	15E		14T(100)	999:59:59		
10	MERGE JOIN		10P	616P		694G (81)	999:59:59		
11	MERGE JOIN		231T	10P		377G (64)	999:59:59		
12	SORT JOIN		334T	11P	28P	377G (64)	999:59:59		
13	MERGE JOIN CARTESIAN		334T	11P		140G (14)	999:59:59		
* 14	HASH JOIN		989M	23G	534M	96010 (38)	00:03:56		
15	VIEW		22M	277M		16808 (12)	00:00:42		
16	TABLE ACCESS FULL	SYS_TEMP_OFDA7485B_6A66C42E	22M	1111M		16808 (12)	00:00:42		
17	VIEW		22M	277M		16808 (12)	00:00:42		
18	TABLE ACCESS FULL	SYS_TEMP_OFDA7485B_6A66C42E	22M	1111M		16808 (12)	00:00:42		
19	BUFFER SORT		337K	4286K		140G (14)	999:59:59		
20	VIEW		337K	4286K		142 (14)	00:00:01		
21	TABLE ACCESS FULL	SYS_TEMP_OFDA7485C_6A66C42E	337K	3956K		142 (14)	00:00:01		
* 22	SORT JOIN		337K	4286K	12M	844 (14)	00:00:03		
23	VIEW		337K	4286K		142 (14)	00:00:01		
24	TABLE ACCESS FULL	SYS_TEMP_OFDA7485C_6A66C42E	337K	3956K		142 (14)	00:00:01		
* 25	SORT JOIN		22M	277M	855M	65084 (16)	00:02:40		
26	VIEW		22M	277M		16808 (12)	00:00:42		
27	TABLE ACCESS FULL	SYS_TEMP_OFDA7485B_6A66C42E	22M	1111M		16808 (12)	0		
* 28	SORT JOIN		22M	277M	855M	65084 (16)	00:02:40		
29	VIEW		22M	277M		16808 (12)	00:00:42		
30	TABLE ACCESS FULL	SYS_TEMP_OFDA7485B_6A66C42E	22M	1111M		16808 (12)	0		

Optimizer Plans (3:4)

```

WITH ed AS (SELECT object_id, element_id, element_name, element_type, useid
             FROM pmcm.element_detail
             WHERE element_type = 'CELL'
             AND current_ind = 'Y'),
     mn AS (SELECT parent_id, object_id
             FROM pmcm.mark_netw_hierarchy
             WHERE current_ind = 'Y'
             AND hierarchy_type = 'NETWORK'
             AND parent_type IN ('BSC', 'RNC'))
SELECT COUNT(*)
FROM ed e1_1, ed e1_2, ed e2_1, ed e2_2, mn h1, mn h2
WHERE e1_1.object_id = h1.parent_id AND e1_2.object_id = h1.object_id
AND e2_1.object_id = h2.parent_id AND e2_2.object_id = h2.object_id
AND e1_1.element_name = e2_1.element_name
AND e1_1.element_id = e2_1.element_id
AND e1_2.element_name = e2_2.element_name
AND e1_2.element_id = e2_2.element_id
AND e1_2.useid LIKE '*%'
AND e2_2.useid NOT LIKE '*%';

```

Id	Operation	Name	Rows	Bytes	TempSpc	Cost (%CPU)	Time
0	SELECT STATEMENT		1	214		100K (6)	00:04:08
1	HASH UNIQUE		1	214		100K (6)	00:04:08
* 2	HASH JOIN		1	214	12M	100K (6)	00:04:08
3	PARTITION HASH ALL		337K	9231K		3514 (15)	00:00:09
* 4	TABLE ACCESS FULL	MARK_NETW_HIERARCHY	337K	9231K		3514 (15)	00:00:00
* 5	HASH JOIN		207K	36M	22M	95860 (6)	00:03:56
6	PARTITION RANGE ALL		586K	15M		16233 (2)	00:00:40
7	TABLE ACCESS BY LOCAL INDEX ROWID	ELEMENT_DETAIL	586K	15M		16233	???:?:??
* 8	INDEX SKIP SCAN	ED_ET_TECH_CI	586K			12791 (1)	00:00:3?
* 9	HASH JOIN		207K	31M	22M	77982 (7)	00:03:12
10	PARTITION RANGE ALL		586K	15M		16233 (2)	00:00:40
11	TABLE ACCESS BY LOCAL INDEX ROWID	ELEMENT_DETAIL	586K	15M		16233	???:?:??
* 12	INDEX SKIP SCAN	ED_ET_TECH_CI	586K			12791 (1)	00:00:??
* 13	HASH JOIN		179K	22M	12M	60372 (8)	00:02:29
14	PARTITION HASH ALL		337K	9231K		3514 (15)	00:00:09
* 15	TABLE ACCESS FULL	MARK_NETW_HIERARCHY	337K	9231K		3514 (15)	00:00:??
* 16	HASH JOIN		184K	17M	10M	55886 (8)	00:02:18
17	PARTITION RANGE ALL		184K	9008K		37137 (8)	00:01:32
* 18	TABLE ACCESS FULL	ELEMENT_DETAIL	184K	9008K		37137 (8)	00:01:32
19	PARTITION RANGE ALL		576K	28M		17383 (8)	00:00:43
* 20	TABLE ACCESS BY LOCAL INDEX ROWID	ELEMENT_DETAIL	576K	28M		17383 (8)	???:?:??
* 21	INDEX SKIP SCAN	ED_ET_TECH_CI	583K			13939 (9)	00:00:35

Optimizer Plans (4:4)

Id	Operation	Name	Rows	Bytes	TempSpc	Cost (%CPU)	Time
0	SELECT STATEMENT					264T (100)	
* 1	VIEW		156P	15E		264T (79)	999:59:59
* 2	WINDOW SORT PUSHED RANK		156P	15E	15E	264T (79)	999:59:59
3	MERGE JOIN CARTESIAN		156P	15E		68T (16)	999:59:59
4	MERGE JOIN CARTESIAN		220G	205T		96M (16)	26:57:48
5	MERGE JOIN CARTESIAN		310K	302M		232 (11)	00:00:01
6	MERGE JOIN CARTESIAN		779	777K		22 (0)	00:00:01
7	NESTED LOOPS						
8	NESTED LOOPS		2	2044		20 (0)	00:00:01
9	NESTED LOOPS OUTER		2	1990		18 (0)	00:00:01
10	NESTED LOOPS		2	1868		17 (0)	00:00:01
11	NESTED LOOPS		2	1712		15 (0)	00:00:01
12	NESTED LOOPS		2	1564		13 (0)	00:00:01
13	MERGE JOIN CARTESIAN		2	1442		11 (0)	00:00:01
14	NESTED LOOPS OUTER		1	625		8 (0)	00:00:01
15	NESTED LOOPS OUTER		1	613		7 (0)	00:00:01
16	NESTED LOOPS		1	580		6 (0)	00:00:01
17	NESTED LOOPS OUTER		1	539		5 (0)	00:00:01
18	NESTED LOOPS OUTER		1	340		5 (0)	00:00:01
19	TABLE ACCESS BY INDEX ROWID	PA_STUDENT	1	316		3 (0)	00:00:01
* 20	INDEX UNIQUE SCAN	PK_STUDENT	1			2 (0)	00:00:01
21	TABLE ACCESS BY INDEX ROWID	PA_STUD_USER	1	24		2 (0)	00:00:01
* 22	INDEX UNIQUE SCAN	PK_STUD_USER	1			1 (0)	00:00:01
23	TABLE ACCESS BY INDEX ROWID	PA_ORG	1	199		0 (0)	
* 24	INDEX UNIQUE SCAN	PK_ORG	1			0 (0)	
25	TABLE ACCESS BY INDEX ROWID	PA_DOMAIN	13	533		1 (0)	00:00:01
* 26	INDEX UNIQUE SCAN	PK_DOMAIN	1			0 (0)	
27	TABLE ACCESS BY INDEX ROWID	PA_USRRF_STUD	100	3300		1 (0)	00:00:01
* 28	INDEX UNIQUE SCAN	PK_USRRF_STUD	1			0 (0)	
29	VIEW PUSHED PREDICATE	PV_STUD_USER	1	12		1 (0)	00:00:01
* 30	FILTER						
31	NESTED LOOPS OUTER		1	22		264 (11)	00:00:01
* 32	INDEX UNIQUE SCAN	PK_STUDENT	1	10		2 (0)	00:00:01
* 33	MAT_VIEW ACCESS FULL	PV_AP_STUD_USER	1	12		262 (11)	00:00:01
34	BUFFER SORT		2	192		10 (0)	00:00:01
35	TABLE ACCESS BY INDEX ROWID	PA_CPNT_COMPLIANCE_DATA	2	192		3 (0)	00:00:01
* 36	INDEX RANGE SCAN	IX_CPNT_CD_EVTHST	2			1 (0)	00:00:01
37	TABLE ACCESS BY INDEX ROWID	PA_CPNT_TYPE	1	61		1 (0)	00:00:01
* 38	INDEX UNIQUE SCAN	PK_CPNT_TYPE	1			0 (0)	
39	TABLE ACCESS BY INDEX ROWID	PA_RQMT_TYPE	1	74		1 (0)	00:00:01
* 40	INDEX UNIQUE SCAN	PK_RQMT_TYPE	1			0 (0)	
41	TABLE ACCESS BY INDEX ROWID	PA_CMPL_STAT	1	78		1 (0)	00:00:01
* 42	INDEX UNIQUE SCAN	PK_CMPL_STAT	1			0 (0)	
43	TABLE ACCESS BY INDEX ROWID	PA_QUAL	1	61		1 (0)	00:00:01
* 44	INDEX UNIQUE SCAN	PK_QUAL	1			0 (0)	
* 45	INDEX UNIQUE SCAN	PK_CPNT	1			0 (0)	
46	TABLE ACCESS BY INDEX ROWID	PA_CPNT	1	27		1 (0)	00:00:01
47	BUFFER SORT		399			21 (0)	00:00:01
48	INDEX FAST FULL SCAN	PK_USRRF_STUD	399			1 (0)	00:00:01
49	BUFFER SORT		399			231 (11)	00:00:01
50	INDEX FAST FULL SCAN	PK_USRRF_STUD	399			0 (0)	
51	BUFFER SORT		710K			96M (16)	26:57:48
52	INDEX FAST FULL SCAN	IX_STUD_USER_STUDENT	710K			309 (16)	00:00:01
53	BUFFER SORT		710K			264T (79)	999:59:59
54	INDEX FAST FULL SCAN	IX_STUD_USER_STUDENT	710K			309 (16)	00:00:01

Poorly Written Applications

- There's nothing wrong with the SQL ... but there is definitely something wrong

SQL ordered by Executions

- Total Executions: 29,717,627
- Captured SQL account for 77.4% of Total

Executions	Rows Processed	Rows per Exec	CPU per Exec (s)	Elap per Exec (s)	SQL Id	SQL Module	SQL Text
10,128,178	2,506,529	0.25	0.00	0.00	932erzq1kc33	ASN_07B_DIP(004110016)	SELECT NE_TIMEZONE FROM CMPM.E...
7,576,759	7,579,197	1.00	0.00	0.00	fh698sb62un99	asci_56_RANAPProtocolStats(01611000E)	SELECT DISTINCT NE_TIMEZONE FR...
3,914,621	3,848,268	0.98	0.00	0.00	5tbzddgguu8cc	asci_56_RANAPProtocolStats(01611000E)	SELECT SYS_VERSION FROM CMPM.T...
311,645	311,604	1.00	0.00	0.00	7qztzzy329wq0		select c.name, u.name from co...
301,428	301,325	1.00	0.00	0.00	36s446f9cnwhw		SELECT C.NAME FROM COL\$ C.WHER...
200,692	200,669	1.00	0.00	0.00	4vs91dcv7urp6	OMS	insert into sys.aud\$(sessioni...
65,044	65,035	1.00	0.00	0.00	fz9xwpt2cut0k		SELECT par_type, param_clob, ...
64,949	3,945,482	60.75	0.00	0.00	f5ta7dru5fk5n	XML_P7R_RNC_RCS(003110008)	SELECT NAME, PATH, READ, VWR...
64,801	64,807	1.00	0.00	0.00	fhcj09a7fmrnb	XML_V7I_IN_LP_DC(00811000V)	SELECT DBTIMEZONE, LENGTH(DBT...
64,632	64,542	1.00	0.00	0.00	f5mrrb6016nd	XML_V7I_IN_LP_DC(00811000V)	SELECT SESSIONTIMEZONE, LENG...

```
SELECT /*+ RESULT_CACHE */ srvr_id
FROM (
  SELECT srvr_id, SUM(cnt) SUMCNT
  FROM (
    SELECT DISTINCT srvr_id, 1 AS CNT
    FROM servers
    UNION ALL
    SELECT DISTINCT srvr_id, 1
    FROM serv_inst)
  GROUP BY srvr_id)
WHERE sumcnt = 2;
```

more examples: www.morganslibrary.org/reference/pkggs/dbms_result_cache.html

Optimizer Settings

- Default Oracle install favors data warehouse not OLTP

NAME	TYPE	VALUE
-----	-----	-----
optimizer_adaptive_features	boolean	TRUE
optimizer_adaptive_reporting_only	boolean	FALSE
optimizer_capture_sql_plan_baselines	boolean	FALSE
optimizer_dynamic_sampling	integer	2
optimizer_features_enable	string	12.1.0.2
optimizer_index_caching	integer	0
optimizer_index_cost_adj	integer	100
optimizer_mode	string	ALL_ROWS
optimizer_secure_view_merging	boolean	TRUE
optimizer_use_invisible_indexes	boolean	FALSE
optimizer_use_pending_statistics	boolean	FALSE
optimizer_use_sql_plan_baselines	boolean	TRUE

```
SQL> show parameter optimizer_mode
```

NAME	TYPE	VALUE
-----	-----	-----
optimizer_mode	string	ALL_ROWS

```
SQL> ALTER SYSTEM SET OPTIMIZER_MODE='FIRST_ROWS_10';
```

```
System altered.
```

```
SQL> show parameter optimizer_mode
```

NAME	TYPE	VALUE
-----	-----	-----
optimizer_mode	string	FIRST_ROWS_10

Best for Data Warehouse

Best for OLTP

more examples: www.morganslibrary.org/reference/startup_parms.html

Optimizer Statistics

- Gather System Stats
- Gather Fixed Object Stats
- Gather Dictionary Stats
- Gather Table Stats
- Gather Column Stats
- Gather Index Stats
- Gather Extended Stats
- Stat Generation
 - Copy Stats
 - Set Stats
 - Fixing Stats

```

Terminal
Window Edit Options
MAXTHR
MBRC
MREADTIM
SLAVETHR
SREADTIM
9 rows selected.
SQL> /
PNAME-----PVAL1
CPUSPEED-----
CPUSPEEDNW      680.062427
IOSEEKTIM        10
IOTFRSPED       4096
MAXTHR
MBRC
MREADTIM
SLAVETHR
SREADTIM
9 rows selected.
SQL> exec dbms_stats.gather_system_stats('STOP');
PL/SQL procedure successfully completed.
SQL> select pname, pval1
       2   from aux_stats$
       3   where pname = 'SYSSTATS_MAIN';
PNAME-----PVAL1
CPUSPEED-----1081
CPUSPEEDNW      680.062427
IOSEEKTIM        10
IOTFRSPED       4096
MAXTHR
MBRC
MREADTIM        .107
SLAVETHR
SREADTIM        .029
9 rows selected.
SQL>
    
```

```

SQL> select type, count(*)
       2   from v$fixed_table
       3   group by type
       4   order by 1;

TYPE      COUNT(*)
-----
TABLE      1144
VIEW      1261

SQL> select name
       2   from v$fixed_table
       3   where rownum < 11;

NAME
-----
X$KQFTA
X$KQFVI
X$KQFVT
X$KQFDT
X$KQFCO
X$KQFOPT
X$KYWMPCTAB
X$KYWMWRCTAB
X$KYWMCLTAB
X$KYWMNF
    
```

more examples: www.morganslibrary.org/reference/system_stats.html

Setting Optimizer Statistics

- Set database, schema, and table stats collection prefs

```
exec dbms_stats.set_table_prefs (USER, 'SERVERS', 'ESTIMATE_PERCENT', '90');  
  
exec dbms_stats.set_table_prefs (USER, 'SERVERS', 'DEGREE', '8');
```

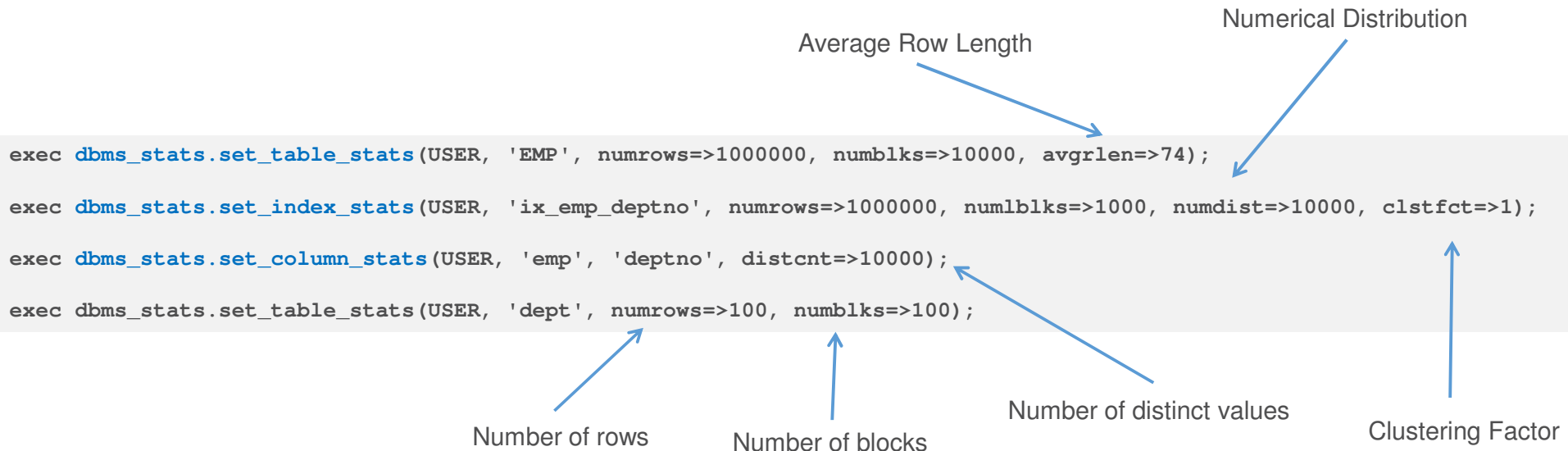
- Where WHERE clause predicates utilize more than a single table column collect extended stats

```
SELECT dbms_stats.create_extended_stats (USER, 'SERV_INST', '(srvr_id, si_status)')  
FROM dual;
```

more examples: www.morganslibrary.org/reference/pkgs/dbms_stats.html

Manufacture Optimizer Statistics

- Creating a new table or partition?
 - If you know approximately what will be in it when it is full set the statistics when you create it
 - If working in a DEV or TEST environment set or import stats to make these environments "look" more like production



more examples: www.morganslibrary.org/reference/pkgs/dbms_stats.html

Diagnostics

Root Cause Analysis by Sophisticated Guessing

- Check data dictionary for collected stats
- Explain Plans
 - Very few people can read them ... I will prove it next
- AWR Reports
 - Data <> Information
 - If you want value from AWR ... create AWR Difference reports with **DBMS_WORKLOAD_REPOSITORY.AWR_DIFF_REPORT_HTML**
- ADDM Difference Reports
- ASH Reports
- SQL Tuning Advisor
- SQL Trace and TKPROF
- Baselines and Evolving Baselines
- DBMS_TRACE, DBMS_MONITOR, TRCSESS, TRACE ANALYZER, SQLTXPLAIN

Reading Explain Plans

- Very few people can read an explain plan
- Here are two plans from identical tables with identical stats
- Which one would you rely on?

Database 11gR2

Id	Operation	Name	Rows	Bytes	Cost (%CPU)
0	SELECT STATEMENT		141	4560	6 (84)
1	INTERSECTION				
2	SORT UNIQUE NOSORT		141	564	2 (50)
3	INDEX FULL SCAN	PK_SERVERS	141	564	1 (0)
4	SORT UNIQUE		999	3996	4 (25)
5	INDEX FAST FULL SCAN	IX_SERV_INST	999	3996	3 (0)

Id	Operation	Name	Rows	Bytes	Cost (%CPU)
0	SELECT STATEMENT		141	4560	20 (10)
1	INTERSECTION				
2	SORT UNIQUE		141	564	10 (10)
3	TABLE ACCESS FULL	SERVERS	141	564	9 (0)
4	SORT UNIQUE		999	3996	10 (10)
5	TABLE ACCESS FULL	SERV_INST	999	3996	9 (0)

Database 12gR1

The SQL Statement

```
SELECT srvr_id
FROM servers
INTERSECT
SELECT srvr_id
FROM serv_inst;
```

```
SQL> SELECT table_name, blocks
2 FROM user_tables
3* WHERE table_name IN ('SERVERS', 'SERV_INST');
```

TABLE_NAME	BLOCKS
SERVERS	28
SERV_INST	28

more examples: www.morganslibrary.org/reference/explain_plan.html

This Adds To The Confusion

```
SQL> SELECT blocks
2  FROM dba_tables
3  WHERE owner = 'UWCLASS'
4  AND table_name = 'SERVERS';
```

BLOCKS

28

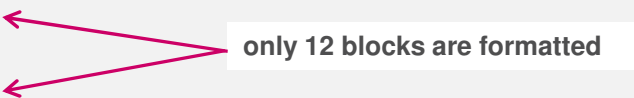
```
SQL> SELECT blocks
2  FROM dba_segments
3  WHERE owner = 'UWCLASS'
4  AND segment_name = 'SERVERS';
```

BLOCKS

32

This Makes It Even Worse

```
SQL> DECLARE
 2  uf    NUMBER;
 3  ub    NUMBER;
 4  f1    NUMBER;
 5  f1b   NUMBER;
 6  f2    NUMBER;
 7  f2b   NUMBER;
 8  f3    NUMBER;
 9  f3b   NUMBER;
10  f4    NUMBER;
11  f4b   NUMBER;
12  fbl   NUMBER;
13  fby   NUMBER;
14 BEGIN
15  dbms_space.space_usage('UWCLASS','SERVERS', 'TABLE', uf, ub, f1, f1b, f2, f2b, f3, f3b, f4, f4b, fbl, fby);
16
17  dbms_output.put_line('unformatted blocks: ' || TO_CHAR(uf));
18  dbms_output.put_line('unformatted bytes: ' || TO_CHAR(ub));
19  dbms_output.put_line('blocks 0-25% free: ' || TO_CHAR(f1));
20  dbms_output.put_line('bytes 0-25% free: ' || TO_CHAR(f1b));
21  dbms_output.put_line('blocks 25-50% free: ' || TO_CHAR(f2));
22  dbms_output.put_line('bytes 25-50% free: ' || TO_CHAR(f2b));
23  dbms_output.put_line('blocks 50-75% free: ' || TO_CHAR(f3));
24  dbms_output.put_line('bytes 50-75% free: ' || TO_CHAR(f3b));
25  dbms_output.put_line('blocks 75-100% free: ' || TO_CHAR(f4));
26  dbms_output.put_line('bytes 75-100% free: ' || TO_CHAR(f4b));
27  dbms_output.put_line('full blocks: ' || TO_CHAR(fbl));
28  dbms_output.put_line('full bytes: ' || TO_CHAR(fby));
29 END;
30 /
unformatted blocks: 16
unformatted bytes: 131072
blocks 0-25% free: 0
bytes 0-25% free: 0
blocks 25-50% free: 1
bytes 25-50% free: 8192
blocks 50-75% free: 0
bytes 50-75% free: 0
blocks 75-100% free: 11
bytes 75-100% free: 90112
full blocks: 0
full bytes: 0
```



only 12 blocks are formatted

more examples: www.morganslibrary.org/reference/pkgsg/dbms_space.html

AWR Difference Reports (1:5)

- SQL scripts located at \$ORACLE_HOME/rdbms/admin

File Name	Strategy
awrddrpi.sql	Report on differences between differences between values recorded in two pairs of snapshots. This script requests the user for the dbid and instance number of the instance to report on, for each snapshot pair, before producing the standard report.
awrddrpt.sql	Defaults the dbid and instance number to that of the current instance connected-to, then calls awrddrpi.sql to produce the Compare Periods report.
awrextr.sql	SQL/Plus script to help users extract data from the AWR.
awrgdrpi.sql	RAC Version of Compare Period Report.
awrgdrpt.sql	This script defaults the dbid to that of the current instance connected-to, defaults instance list to all available instances and then calls awrgdrpi.sql to produce the Workload Repository RAC Compare Periods report.
awrg rpt.sql	This script defaults the dbid to that of the current instance connected-to, then calls awrg rpti.sql to produce the Workload Repository RAC report.
awrg rti.sql	SQL*Plus command file to report on RAC-wide differences between values recorded in two snapshots. This script requests the user for the dbid before producing the standard Workload Repository report.

more examples: www.morganslibrary.org/reference/awr_report.html

AWR Difference Reports (2:5)

- SQL scripts located at \$ORACLE_HOME/rdbms/admin

File Name	Strategy
awrinfo.sql	Outputs general AWR information such as the size, data distribution, etc. in AWR and SYSAUX. The intended use of this script is for diagnosing abnormalities in AWR and not for diagnosing issues in the database instance.
awrrpt.sql	Defaults the dbid and instance number to that of the current instance connected-to, then calls awrrpti.sql to produce the report.
awrrpti.sql	SQL*Plus command file to report on differences between values recorded in two snapshots. This script requests the user for the dbid and instance number of the instance to report on, before producing the standard report.
awrsqrpi.sql	SQL*Plus command file to report on differences between values recorded in two snapshots. This script requests the user for the dbid, instance number and the sql id, before producing a report for a particular sql statement in this instance.
awrsqrpt.sql	Defaults the dbid and instance number to that of the current instance connected-to then calls awrsqrpi.sql to produce a Workload report for a particular sql statement.
awrupd12.sql	This script updates AWR data to version 12c. It only modifies AWR data that has been imported using awrload.sql, or data from before changing the database DBID. In other words, it doesn't modify AWR data for the local, active DBID.

more examples: www.morganslibrary.org/reference/awr_report.html

AWR Difference Reports (3:5)

WORKLOAD REPOSITORY COMPARE PERIOD REPORT

Snapshot Set	DB Name	DB Id	Instance	Inst num	Release	Cluster	Host	Std Block Size
First (1st)	ORAP09	2886124853	orap09	1	11.2.0.3.0	NO	db20p03sh	8192
Second (2nd)	ORAP09	2886124853	orap09	1	11.2.0.3.0	NO	db20p03sh	8192

Snapshot Set	Begin Snap Id	Begin Snap Time	End Snap Id	End Snap Time	Avg Active Users	Elapsed Time (min)	DB time (min)
1st	33759	02-Apr-14 04:00:19 (Wed)	33760	02-Apr-14 04:30:22 (Wed)	0.8	30.1	24.5
2nd	33807	03-Apr-14 04:00:13 (Thu)	33808	03-Apr-14 04:30:16 (Thu)	1.0	30.1	29.8
%Diff					22.2	0.0	21.6

Host Configuration Comparison

	1st	2nd	Diff	%Diff
Number of CPUs:	80	80	0	0.0
Number of CPU Cores:	40	40	0	0.0
Number of CPU Sockets:	4	4	0	0.0
Physical Memory:	1031464.9M	1031464.9M	0M	0.0
Load at Start Snapshot:	19.09	20.68	1.59	8.3
Load at End Snapshot:	11.49	11.18	-.31	-2.7
%User Time:	14.88	14.44	-.44	-3.0
%System Time:	1.08	1.05	-.03	-2.8
%Idle Time:	83.92	84.38	.46	0.5
%IO Wait Time:	.31	.45	.13	45.2

more examples: www.morganslibrary.org/reference/awr_report.html

AWR Difference Reports (4:5)

Wait Events

- Ordered by absolute value of 'Diff' column of '% of DB time' descending (idle events last)

Event	Wait Class	% of DB time			# Waits/sec (Elapsed Time)			Total Wait Time (sec)			Avg Wait Time (ms)		
		1st	2nd	Diff	1st	2nd	%Diff	1st	2nd	%Diff	1st	2nd	%Diff
db file scattered read	User I/O	0.01	4.46	-4.45	2.30	544.72	23,583.48	0.21	79.69	37,847.62	0.05	0.08	60.00
read by other session	User I/O	0.00	0.88	0.87	0.35	66.08	18,780.00	0.03	15.65	52,066.67	0.05	0.13	160.00
log file parallel write	System I/O	3.80	3.41	-0.39	11.54	11.64	0.87	55.83	60.88	9.05	2.68	2.90	8.21
db file sequential read	User I/O	0.66	0.85	0.19	12.60	108.69	762.62	9.72	15.24	56.79	0.43	0.08	-81.40
enq: CR - block range reuse dkpt	Other	0.26	0.17	-0.09	0.40	0.31	-22.50	3.83	2.99	-21.93	5.24	5.35	2.10
log file sync	Commit	3.17	3.11	-0.06	8.42	9.26	9.98	46.65	55.59	19.16	3.07	3.33	8.47
SQL*Net message to client	Network	0.06	0.12	0.06	724.68	1,868.96	157.90	0.85	2.08	144.71	0.00	0.00	0.00
utl_file I/O	User I/O	0.23	0.19	-0.04	85.50	84.68	-0.96	3.40	3.34	-1.76	0.02	0.02	0.00
enq: RO - fast object reuse	Application	0.12	0.08	-0.03	0.41	0.31	-24.39	1.72	1.50	-12.79	2.34	2.68	14.53
db file async I/O submit	System I/O	1.29	1.26	-0.03	5.49	5.96	8.56	18.97	22.51	18.66	1.91	2.09	9.42
control file parallel write	System I/O	0.35	0.32	-0.03	0.75	0.73	-2.67	5.09	5.66	11.20	3.75	4.32	15.20
library cache: mutex X	Concurrency	0.05	0.02	-0.03	1.46	1.10	-24.66	0.77	0.42	-45.45	0.29	0.21	-27.59
latch free	Other	0.05	0.03	-0.02	0.34	0.31	-8.82	0.76	0.60	-21.05	1.23	1.08	-12.20
direct path write	User I/O	0.06	0.05	-0.01	1.67	2.14	28.14	0.90	0.85	-5.56	0.30	0.22	-26.67
direct path write temp	User I/O	0.37	0.39	0.01	1.52	2.30	51.32	5.46	6.88	26.01	1.99	1.66	-16.58
reliable message	Other	0.03	0.02	-0.01	0.81	0.62	-23.46	0.47	0.37	-21.28	0.32	0.33	3.13
log buffer space	Configuration	0.02	0.01	-0.01	0.01	0.01	0.00	0.23	0.11	-52.17	14.15	8.65	-38.87
db file parallel write	System I/O	0.03	0.02	-0.01	0.10	0.08	-20.00	0.40	0.38	-5.00	2.31	2.71	17.32
control file sequential read	System I/O	0.01	0.00	-0.00	5.45	4.86	-10.83	0.10	0.09	-10.00	0.01	0.01	0.00
SQL*Net more data from client	Network	0.01	0.01	-0.00	1.98	1.89	-4.55	0.11	0.10	-9.09	0.03	0.03	0.00
SQL*Net more data to client	Network	0.01	0.01	-0.00	3.84	3.94	2.60	0.12	0.12	0.00	0.02	0.02	0.00
asynch descriptor resize	Other	0.00	0.00	-0.00	2.45	2.43	-0.82	0.05	0.05	0.00	0.01	0.01	0.00
cursor: pin S	Concurrency	0.00	0.00	0.00	0.04	0.03	-25.00	0.00	0.01	100.00	0.01	0.23	2,200.00
latch: redo writing	Configuration	0.00	0.00	-0.00	0.06	0.04	-33.33	0.02	0.01	-50.00	0.17	0.16	-5.88
latch: messages	Other	0.00	0.00	-0.00	0.16	0.13	-18.75	0.04	0.04	0.00	0.14	0.17	21.43
direct path read temp	User I/O	0.00	0.00	-0.00	0.63	0.48	-23.81	0.02	0.01	-50.00	0.02	0.02	0.00
direct path sync	User I/O	0.01	0.00	-0.00	0.02	0.03	50.00	0.08	0.09	12.50	2.19	1.78	-19.63
latch: cache buffers chains	Concurrency	0.00	0.00	0.00	0.14	0.63	350.00	0.02	0.03	50.00	0.06	0.02	-66.67

more examples: www.morganslibrary.org/reference/awr_report.html

AWR Difference Reports (5:5)

Other Instance Activity Stats

• Ordered by statistic name

Statistic	Value			per Second (DB time)			per Second (Elapsed Time)			per Trans		
	1st	2nd	%Diff	1st	2nd	%Diff	1st	2nd	%Diff	1st	2nd	%Diff
calls to komgas	44,985	48,775	8.43	30.82	27.31	-10.81	24.94	27.04	8.42	2.48	2.51	1.21
calls to komgas	327,106	351,412	7.41	222.67	196.76	-11.64	181.40	194.84	7.41	18.03	18.07	0.22
cell physical IO interconnect bytes	2,106,564,608	100,858,843,136	4,687.84	1,433,726.13	56,473,555.08	3,838.94	1,167,996.50	55,921,065.97	4,687.78	116,108.95	5,186,077.91	4,366.56
change write time	518	468	-9.65	0.35	0.26	-25.71	0.29	0.26	-10.34	0.03	0.02	-33.33
cleanout - number of ktugdt calls	1,431	1,349	-5.73	0.97	0.76	-21.65	0.79	0.75	-5.06	0.08	0.07	-12.50
cleanouts and rollbacks - consistent read gets	10	29	190.00	0.01	0.02	100.00	0.01	0.02	100.00	0.00	0.00	0.00

more examples: www.morganslibrary.org/reference/awr_report.html

DBMS_ADDM

- **COMPARE_DATABASES**  new in Database 12c
 - Create a report comparing the performance of a database over two different time periods or the performance of two different databases over two different time periods
- **COMPARE_INSTANCES**  new in Database 12c
 - Create a report comparing the performance of a single instance over two different time periods or the performance of two different instances over two different time periods

```
dbms_addm.compar_databases(  
  base_dbid           IN NUMBER,  
  base_begin_snap_id  IN NUMBER,  
  base_end_snap_id    IN NUMBER,  
  comp_dbid           IN NUMBER,  
  comp_begin_snap_id  IN NUMBER,  
  comp_end_snap_id    IN NUMBER,  
  report_type         IN VARCHAR2 := 'HTML')  
RETURN CLOB
```

```
dbms_addm.compare_instances(  
  base_dbid           IN NUMBER,  
  base_instance_id    IN NUMBER,  
  base_begin_snap_id  IN NUMBER,  
  base_end_snap_id    IN NUMBER,  
  comp_dbid           IN NUMBER,  
  comp_instance_id    IN NUMBER,  
  comp_begin_snap_id  IN NUMBER,  
  comp_end_snap_id    IN NUMBER,  
  report_type         IN VARCHAR2 := 'HTML')  
RETURN CLOB;
```

Wrap-Up

Summary

- Do not guess
 - If your problem is not caused by slow hardware then faster hardware will just create a problem faster
 - Gather information from a date-time range when everything was good and compare with the date-time range when the problem was observed
 - If the problem is slow SQL ... is the SQL statement itself slow or is it the entire environment that should be examined?
 - If the problem is related to CPU ... do you need more/faster CPUs or a better design?
 - If the problem is related to I/O ... do you need a new SAN or better indexing?
 - If the problem is related to network bandwidth ... do you need new NIC cards and to stop network virtualization? Yes you probably do

Conclusion

- Do not tune by guessing
 - Do not blame everything on bad SQL statements
 - Until you can prove that the root cause is the SQL
 - Use the scientific method
 - Construct a hypothesis
 - Test the hypothesis by doing experiments
 - Validate your conclusion
 - Only rewrite SQL after you have established conclusively that the root cause is the way a statement has been written and that rewriting the SQL statement will address ALL issues
-
- You will most likely rewriting very few SQL statements

*

ERROR at line 1:

ORA-00028: your session has been killed

Thank You

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