Laugh Your Way To Understanding Oracle, Queuing Theory & Performance

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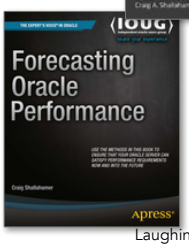
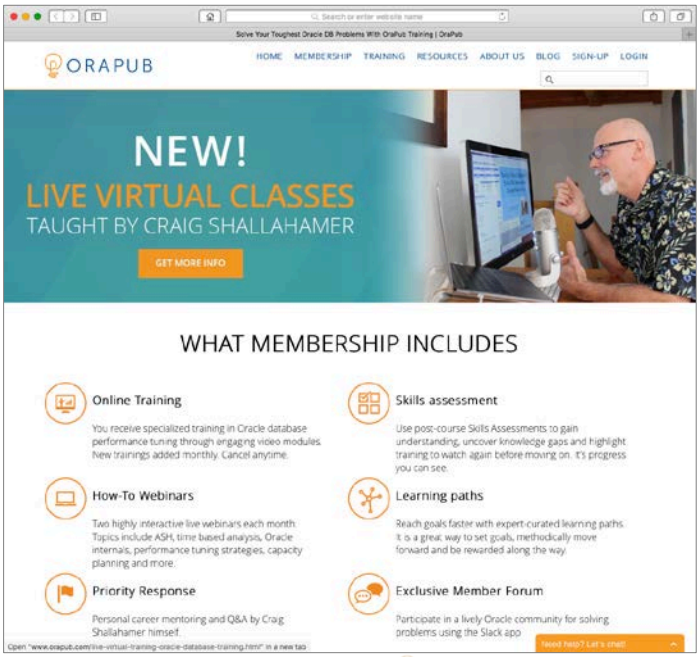
BULGARIAN ORACLE USER GROUP

This presentation was given by Craig Shallahamer (craig@orapub.com) at the November 2017 Bulgaria OUG (BGOUG) conference in Sophia, Bulgaria.

About Me...

- Long time Oracle DBA
- Specialize in Oracle Database performance and predictive analysis
- Performance researcher
- Blogger: A Wider View About Oracle Performance Tuning
- Author: Oracle Performance Firefighting and Forecasting Oracle Performance.
- Conference speaker
- Teacher and mentor
- Oracle ACE Director
- IOUG DBA Track Manager





OraPub works closely with DBAs who want to take their Oracle tuning skills to the next level.

So, you can solve the toughest Oracle DB problems.

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How connect with Craig and OraPub

slack — Community with a common goal

craig@orapub.com

@OraPubInc

ORAPUB — OraPub.Com: Everything starts here!

LinkedIn — Connect and network

The Plan

- Live queuing theory
- Work and time
- Super fun definitions
- Utilization explored
- Response time explored
- Using queuing theory

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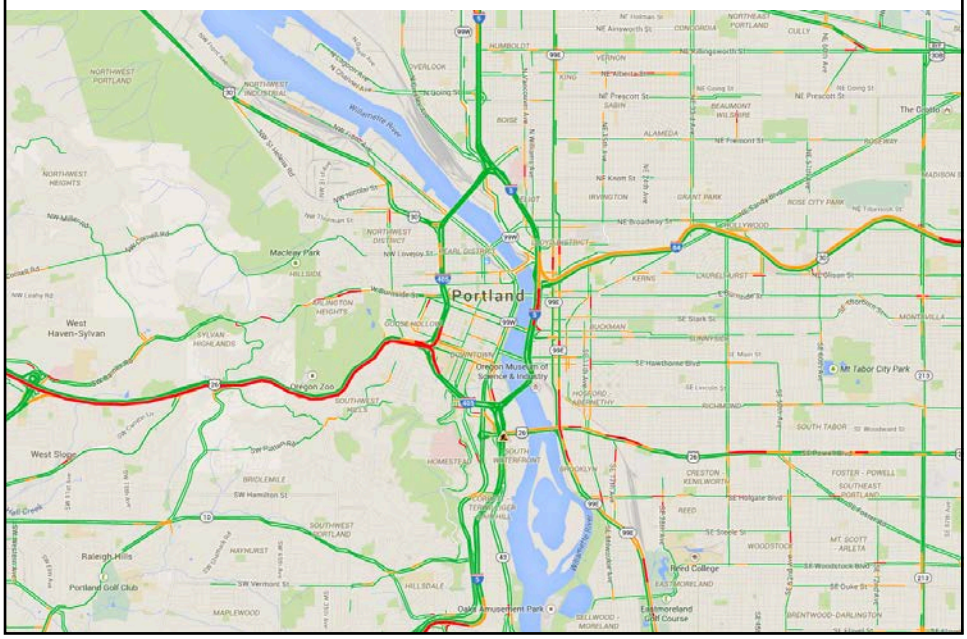
How everyone experiences queuing theory

We live a queuing theory life



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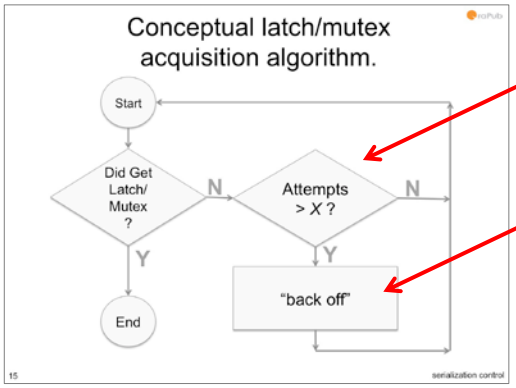
Oracle memory structure serialization control



IO subsystems

```
$ iostat –x 15 999999
Linux 3.8.13-55.1.8.el6uek.x86_64 (sixcore)      04/06/2015      _x86_64_   (6 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.19    0.00    0.09    0.15    0.00   99.57

Device:         rrqm/s   wrqm/s     r/s     w/s    rsec/s    wsec/s avgrq-sz avgqu-sz   await  svctm  %util
sda               0.00     0.00    0.00  124.00      0.00 124069.33  1000.56    42.74  344.68   4.23  52.43
dm-0              0.00     0.00    0.00  121.33      0.00 124026.67  1022.20    42.38  349.27   4.04  49.03
dm-1              0.00     0.00    0.00    0.00      0.00      0.00     0.00     0.00    0.00   0.00   0.00
sdb               0.00     0.00    0.00    0.00      0.00      0.00     0.00     0.00    0.00   0.00   0.00
dm-2              0.00     0.00    0.00    2.67      0.00     42.67    16.00     0.44  163.75  81.88  21.83

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.06    0.00    0.06    0.33    0.00   99.55

Device:         rrqm/s   wrqm/s     r/s     w/s    rsec/s    wsec/s avgrq-sz avgqu-sz   await  svctm  %util
sda               0.00     3.33    0.00    7.33      0.00    101.33    13.82     0.06    8.50   5.68   4.17
dm-0              0.00     0.00    0.00    2.33      0.00     18.67     8.00     0.01    5.57   5.57   1.30
dm-1              0.00     0.00    0.00    0.00      0.00      0.00     0.00     0.00    0.00   0.00   0.00
sdb               0.00     0.00    0.00    0.00      0.00      0.00     0.00     0.00    0.00   0.00   0.00
dm-2              0.00     0.00    0.00    7.67      0.00     82.67    10.78     0.05    6.48   3.74   2.87
```

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A good prediction identifies future risk and provides insights

The Key: mathematically relating work & time

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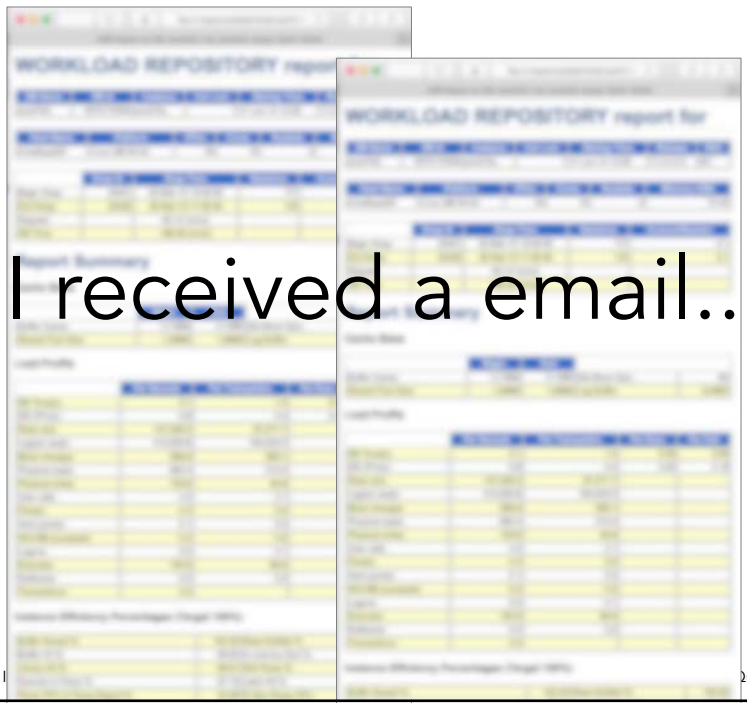

I received a email...

Focusing on time: CPU & wait

WORKLOAD REPOSITORY report for

DB Name	DB Id	Instance	Inst num	Release	RAC	Host
PROD15	3466472990	PROD15	1	10.2.0.3.0	NO	clue

Top 5 Timed Events

Event	Waits	Time(s)	Avg Wait(ms)	% Total Call Time	Wait Class
CPU time		3,641		66.3	
db file sequential read	489,550	587	1	10.7	User I/O
db file scattered read	12,142	565	47	10.3	User I/O
direct path read temp	34,932	470	13	8.6	User I/O
log file parallel write	6,253	235	38	4.3	System I/O

```
source: http://filebank.orapub.com/perf_stats/AWR_PROD15.html
60 minute interval, lio 23,647,386
```


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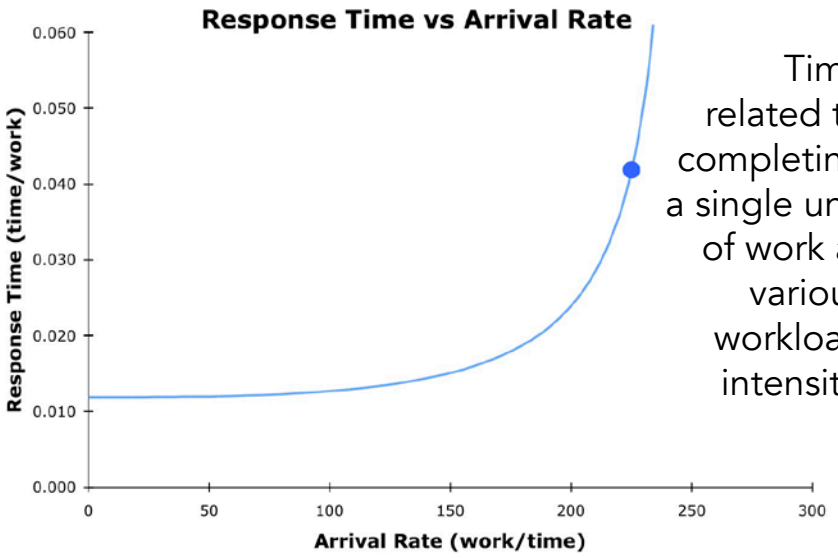
Focusing on work.

Load Profile

	Per Second	Per Transaction
Redo size:	948,397.88	1,761,544.94
Logical reads:	6,562.64	12,189.37
Block changes:	740.05	1,374.57
Physical reads:	735.51	1,366.14
Physical writes:	464.54	862.84
User calls:	101.98	189.42
Parses:	22.08	41.01
Hard parses:	2.68	4.98
Sorts:	14.01	26.02
Logons:	0.32	0.59
Executes:	82.31	152.89
Transactions:	0.54	

Showing both work and time.



Time related to completing a single unit of work at various workload intensity.

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D e f i n i t i o n s

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Key Definitions #1

- Unit of work. Everything in queuing theory ultimately relates to the time related to processing a single piece of work, that is a unit of work.
  - transaction, buffer get, order, SQL statement, etc.
- Arrival rate. The rate of UOW arriving into the system for processing.
  - 650 trx/ms
- Service time. How long it takes to service a UOW.
  - 5.6 ms/trx
- Queue time. How long the UOW is waiting to be serviced.
  - 1.4 ms/trx

Key Definitions #2

- Response time. How long it takes to process (queue & service) a single UOW.
  - 6.0 ms/trx
- Server. Something that services a UOW.
  - 5 CPU cores
- Utilization. The busyness of a server.
  - 0.74 = 74%

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Utilization Explored

Utilization is a very simple concept.

The question is,"Will it all fit?"

Requirements

Capacity

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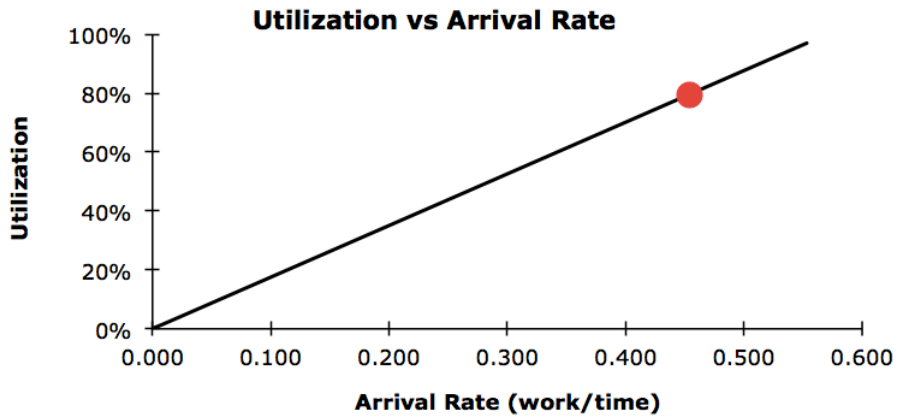
$$U = \frac{R}{C}$$



source: OraPub.com - RT Interactive Graphs

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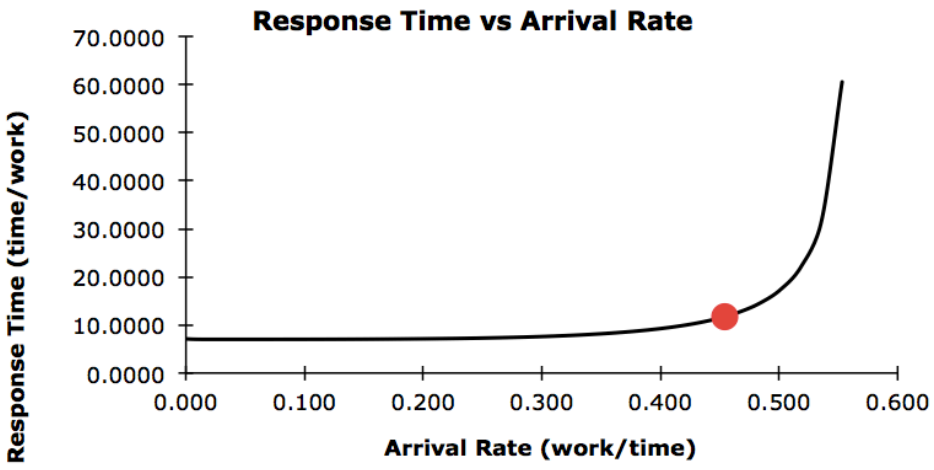
Response Time Explored



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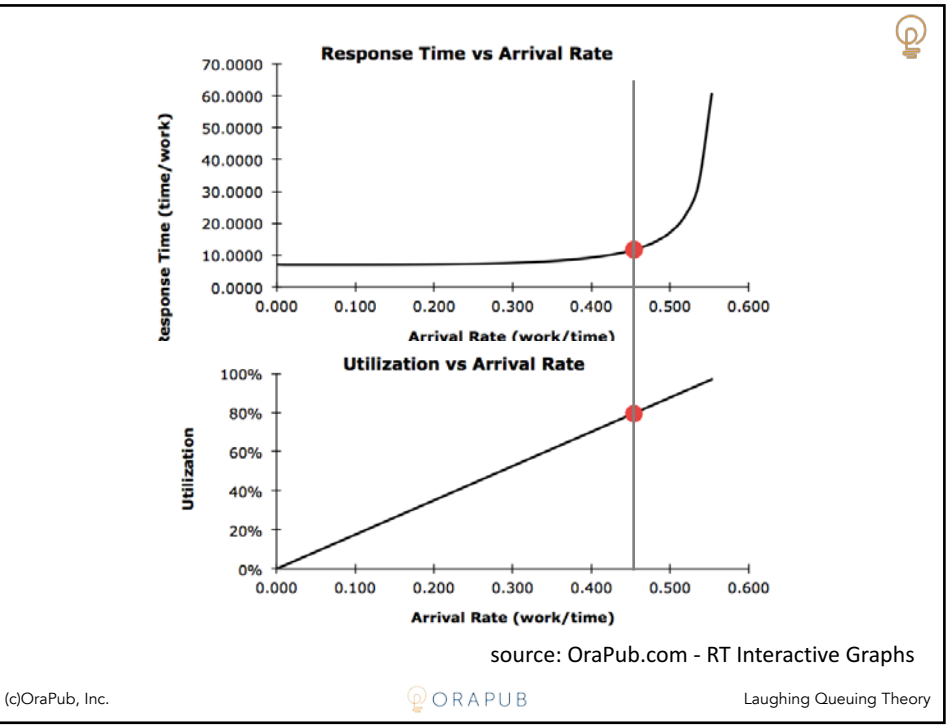
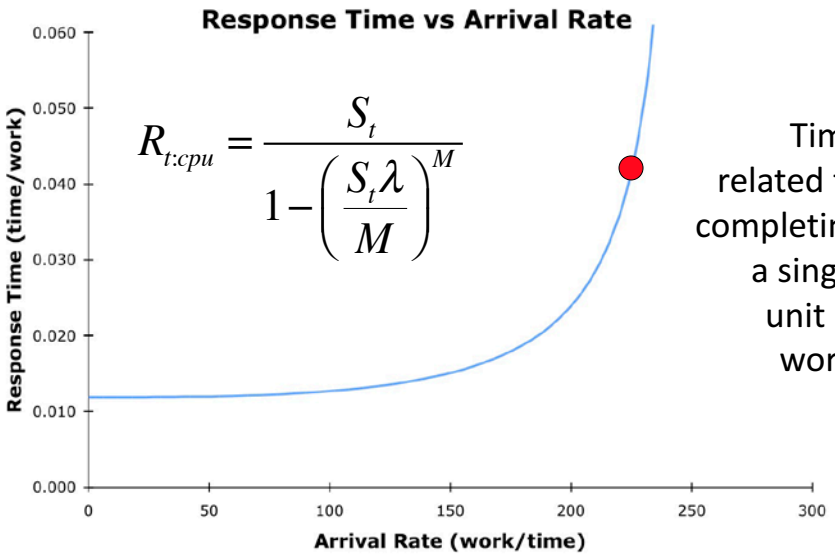


source: OraPub.com - RT Interactive Graphs

The Math



$$R_{t:cpu} = \frac{S_t}{1 - \left(\frac{S_t \lambda}{M}\right)^M}$$

Time related to completing a single unit of work.

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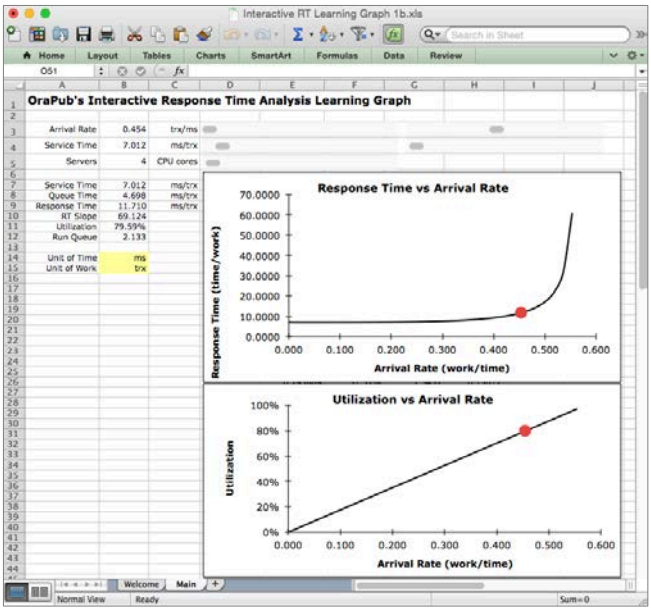

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How we can use queuing theory

in performance tuning

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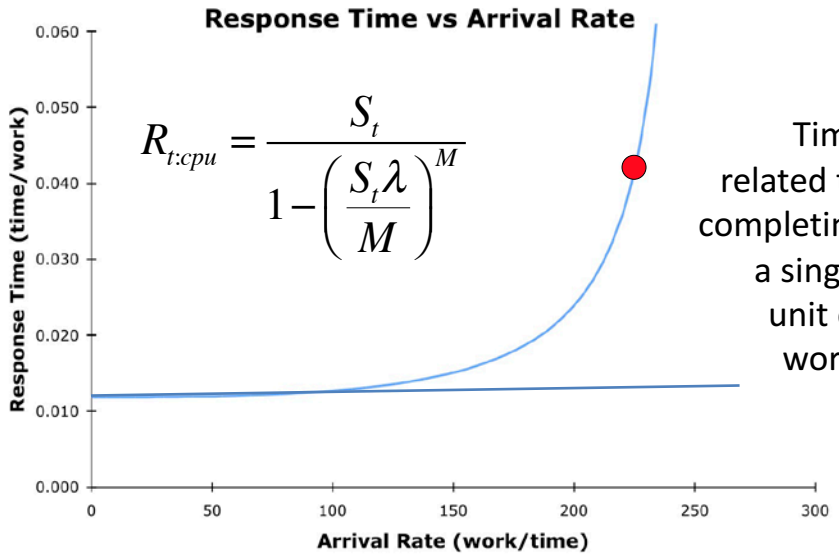
Using one piece of work time.



Time related to completing a single unit of work.

Example of elapsed time.

Supposed a query must access 100,000 logical IOs and each LIO takes 0.020ms. Therefore, the elapsed time will be 2,000ms or 2.0 seconds.

```
E (ms/exec)  = units of work (LIO/exec) X time per work (ms/LIO)

2000 ms/exec = 100,000 LIO/exec         X 0.020 ms/LIO
```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What is the average SQL elapsed time?

SQL ordered by Gets

- Resources reported for PL/SQL code includes the resources used by all SQL statements called by the code.
- Total Buffer Gets: 338,974,131
- Captured SQL account for 99.6% of Total

Buffer Gets	Executions	Gets per Exec	%Total	CPU Time (s)	Elapsed Time (s)	SQL Id	SQL Modu
296,867,461	10	29,686,746.10	87.58	12530.67	27016.25	6mpgg9kthmtm4	AHLWUEFF
30,903,598	300	103,011.99	9.12	235.69	686.01	akpdj9s4ug2s2	JDBC Thin Client
18,552,460	116,739	158.92	5.47	326.80	1275.65	bz0hcf42a1tr9	AHLWUEFF

```
E (sec/exec)     = Total Elapsed Time (sec) / Total Executions (exec)

2701.6 sec/exec = 27016.25 sec              / 10 exec
```

SQL ordered by Gets

- Resources reported for PL/SQL code includes the resources used by all SQL statements called by the code.
- Total Buffer Gets: 338,974,131
- Captured SQL account for 99.6% of Total

Buffer Gets	Executions	Gets per Exec	%Total	CPU Time (s)	Elapsed Time (s)	SQL Id	SQL Module
296,867,461	10	29,686,746.10	87.58	12530.67	27016.25	6mpgg9kthmtm4	AHLWUEFF
151,868,722	20,037	7,579.41	44.80	1744.62	3564.62	1g6t3vmkupthp	AHLWUEFF
43,678,940	275,394	158.61	12.89	3884.10	9359.38	2paw1s1b4t4ab	ahl.pln.workbench.server.XxAdatAhlPlnWorkb
30,903,598	300	103,011.99	9.12	235.69	686.01	akpdj9s4ug2s2	JDBC Thin Client
18,552,460	116,739	158.92	5.47	326.80	1275.65	bz0hcM2a1tr9	AHLWUEFF

```
E (s/exec) = units of work (LIO/exec) X time per work (sec/LIO)

2702 sec/exec  = 29,686,746 LIO/exec  X (27,016 sec / 296,867,461 LIO)

2701 sec/exec  = 29,686,746 LIO/exec  X 0.000091 sec/LIO
```

Source: CMG

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How we can use queuing theory

in predictive analysis

What if... we double the workload?

- Source: sar -u, OS admin, or
  http://filebank.orapub.com/perf_stats/SP_felix.htm
- From our data gathered:
  - 16 dual-core CPUs.
  - CPU utilization is 35%.
  - Arrival rate is 11.076 uc/ms.
- So…
  - S = 1.011 ms/uc
  - R = 1.011 ms/uc
  - Q = 0 ms/uc
- If we double the workload, is there a significant risk of poor performance?

Here's the math.

$$S = UM/\lambda = 1.011 \text{ ms/uc}$$
$$R_{cpu} = S/(1-U^M) = 1.011 \text{ ms/uc}$$
$$Q = R-S = 0$$

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The questions are limitless...

- Will your system handle 20% more users?
- Will RAC provide the performance you need?
- Are you able to consolidate multiple database into a single server?
- What will happen if you place a new SQL statement into production?
- Does it make sense to upgrade to a different hardware configuration?

What if….

- What will buying faster CPUs do?
- What will buying more CPUs do?
- What will increasing parallelism do?

What changes? M, St, λ

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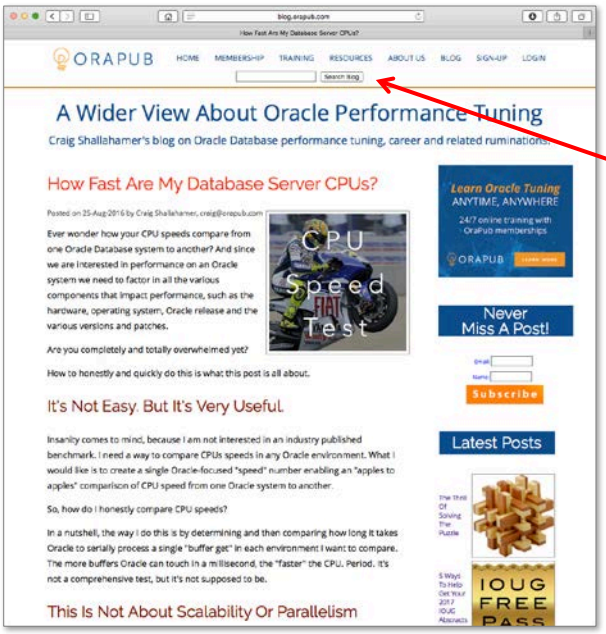

uowtba, time, queuing, unit of work

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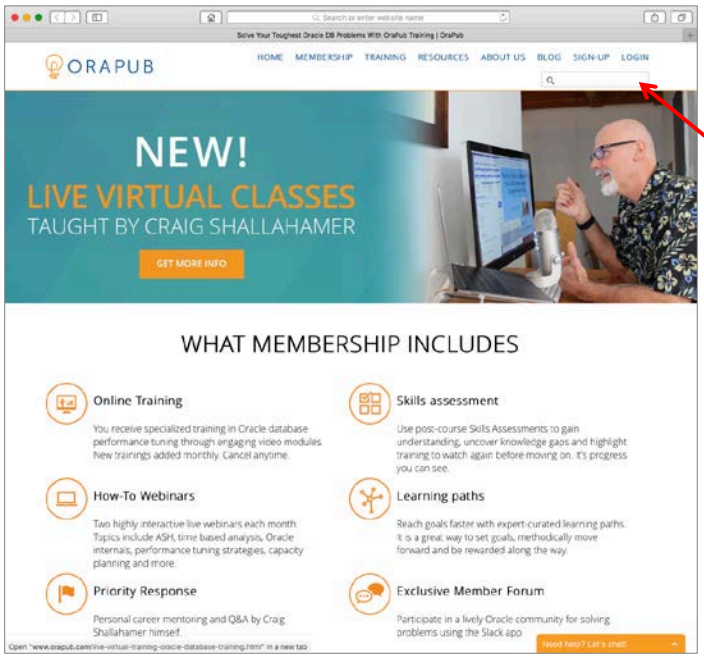

uowtba, time, queuing, unit of work

Resource listing

- **OraPub Membership** for premium content
  - Webinars – two each month
  - Video Seminars – any device, any time, high quality
  - Learning paths, mentoring, assessments and certificates, priority response
- **Live Virtual Classroom (LVC) Training**
  - Oracle Tuning Fastpath
  - Tuning Oracle Using An AWR Report
  - Tuning Oracle Using Advanced Active Session History (ASH) Strategies
  - Oracle Buffer Cache Performance Analysis & Tuning
  - Oracle Predictive Analysis Using Linear Regression
- **Toolkits** – Many tools available at orapub.com
- **Craig's Blog & Website** – Search: "uowtba", "queue"
- **Presentations** – Search OraPub.com: "uowtba"," queue"
- **Books**
  - Oracle Performance Firefighting.
  - Forecasting Oracle Performance.

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