

# Laugh Your Way To Understanding Oracle, Queuing Theory & Performance



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

## About Me...

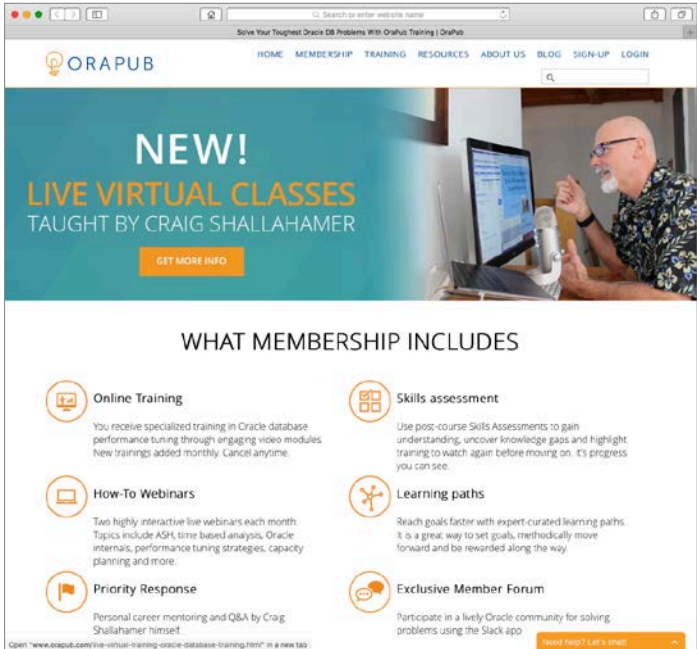
- Long time Oracle DBA
- Specialize in Oracle Database performance and predictive analysis
- Performance researcher
- Blogger: A Wider View About Oracle Performance Tuning
- Author: Oracle Performance Firefighting and Forecasting Oracle Performance.
- Conference speaker
- Teacher and mentor
- Oracle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



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So, you can solve the toughest Oracle DB problems.


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## How connect with Craig and OraPub




Community with a common goal




[craig@orapub.com](mailto:craig@orapub.com)




[@OraPubInc](https://twitter.com/OraPubInc)



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Connect and network

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# The Plan

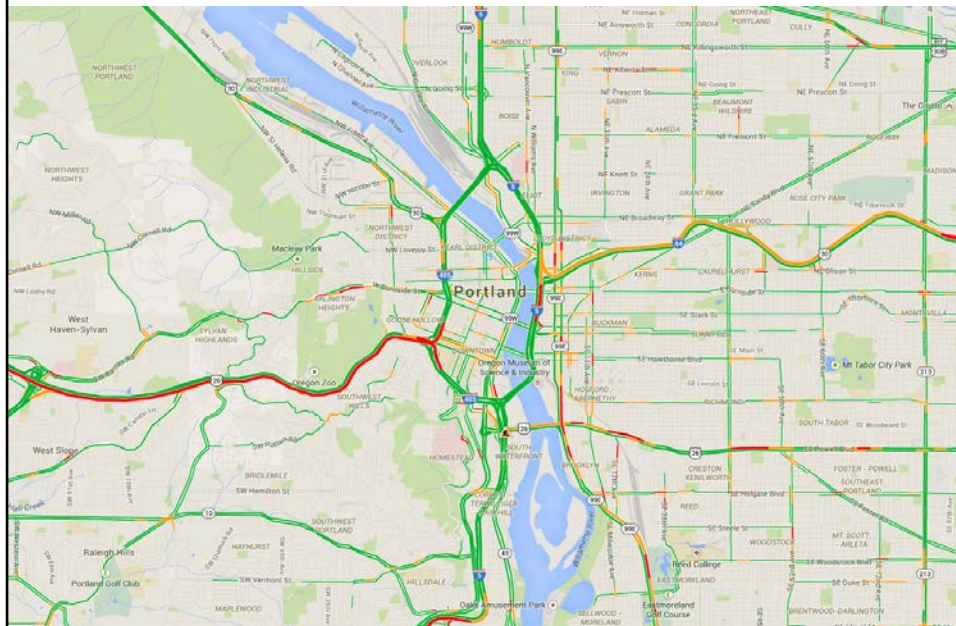


- » Live queuing theory
- » Work and time
- » Super fun definitions
- » Utilization explored
- » Response time explored
- » Using queuing theory

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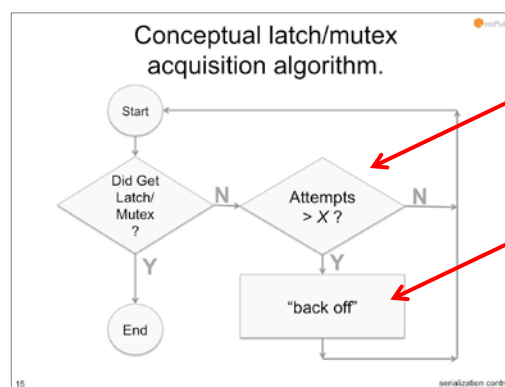
How everyone  
experiences queuing  
theory

# 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

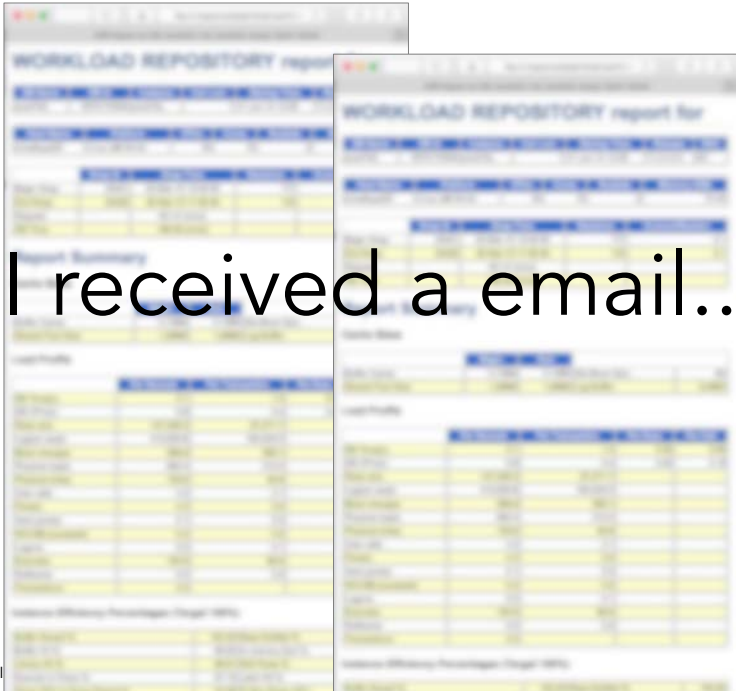
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# The Key: mathematically relating work & time

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I received a email...

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# 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](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

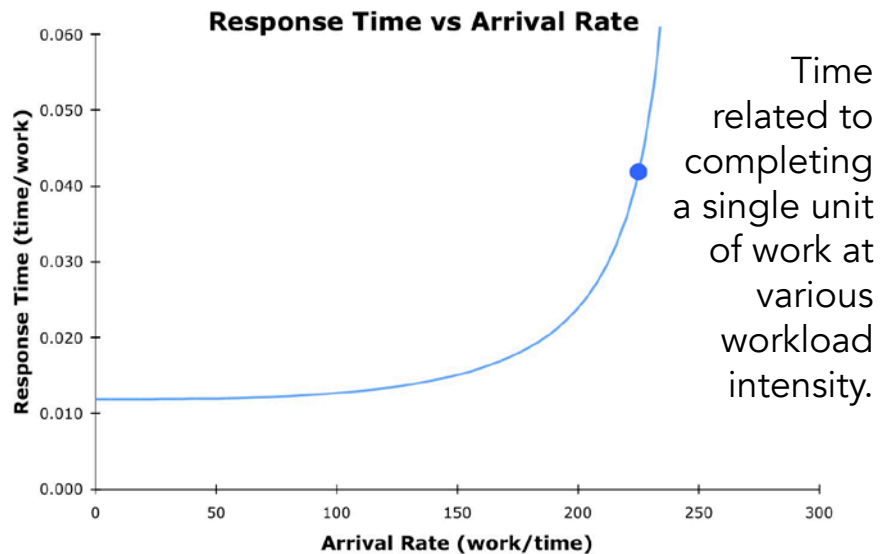
	Per Second	Per Transaction
Redo size:	948,397.88	1,761,544.94
Logical reads:	6,562.64	12,189.37
Block changes:	740.05	1,374.57
Physical reads:	735.51	1,366.14
Physical writes:	464.54	862.84
User calls:	101.98	189.42
Parses:	22.08	41.01
Hard parses:	2.68	4.98
Sorts:	14.01	26.02
Logons:	0.32	0.59
Executes: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

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Showing both work and time. 💡



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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

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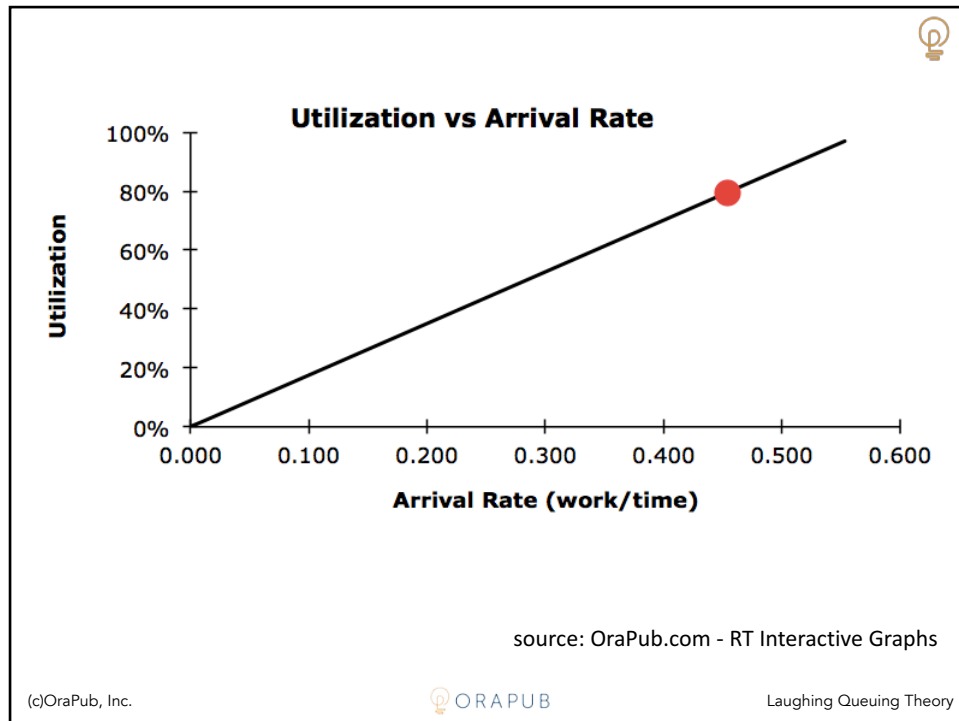
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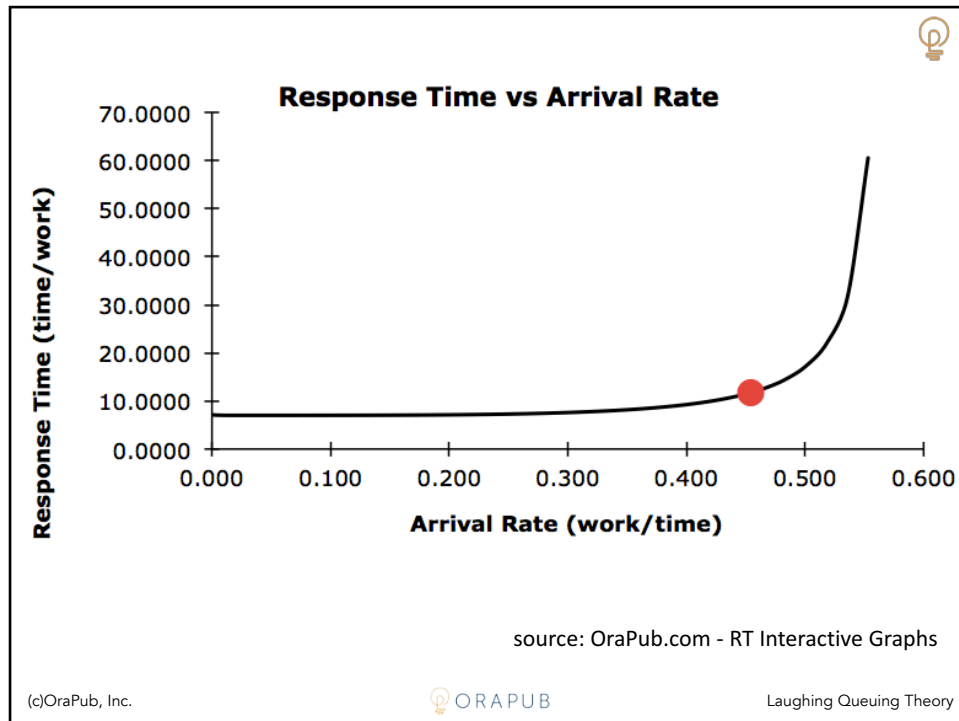
$$U = \frac{R}{C}$$



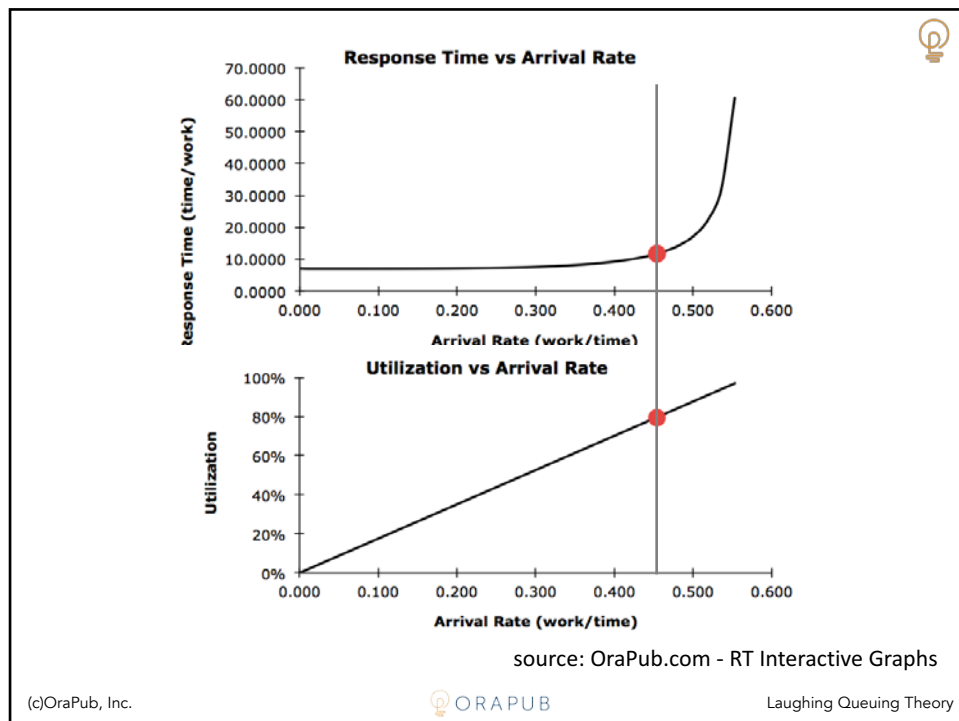


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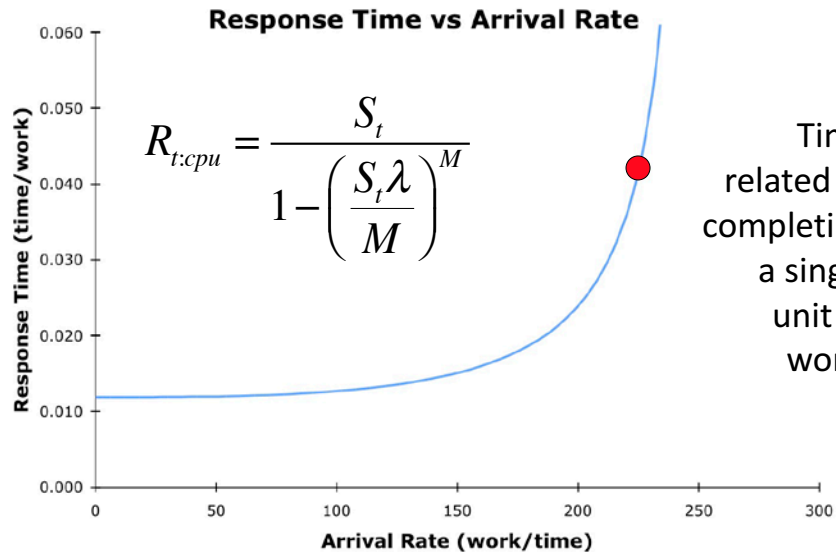
Response Time  
Explored



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# The Math

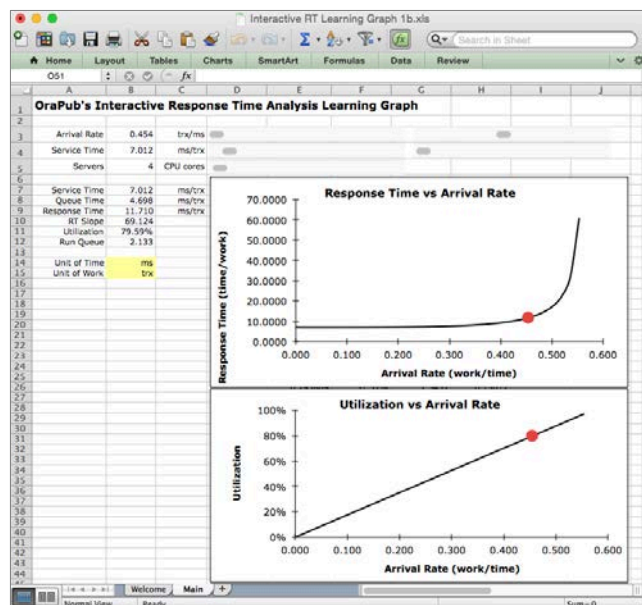


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source: OraPub.com - RT Interactive Graphs

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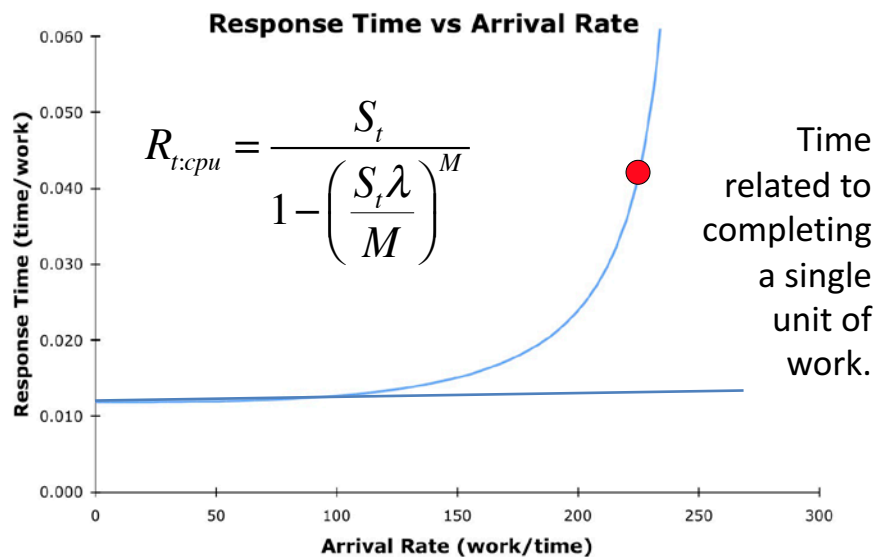


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# How we can use queuing theory in performance tuning

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## Using one piece of work time.



## 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.



$$E \text{ (ms/exec)} = \text{units of work (LIO/exec)} \times \text{time per work (ms/LIO)}$$

$$2000 \text{ ms/exec} = 100,000 \text{ LIO/exec} \times 0.020 \text{ ms/LIO}$$

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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 Mod
296,867,461	10	29,686,746.10	87.58	12530.67	27016.25	6mpgg9kthmtm4	AHLWUEFF
$E \text{ (sec/exec)} = \text{Total Elapsed Time (sec)} / \text{Total Executions (exec)}$ $2701.6 \text{ sec/exec} = 27016.25 \text{ sec} / 10 \text{ exec}$							
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



## SQL ordered by Gets

- Resources reported for PL/SQL code includes the resources used by all SQL statements called by the code.
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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	9.42	235.69	686.01	akpdj9s4ug2s2	JDBC Thin Client
18,552,460	116,739	158.92	5.47	326.80	1275.65	bz0hcm42a1tr9	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](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.

Here's the math.

» So...

- $S = 1.011 \text{ ms/uc}$
- $R = 1.011 \text{ ms/uc}$
- $Q = 0 \text{ ms/uc}$

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

» If we double the workload,  
is there a significant risk of  
poor performance?

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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....

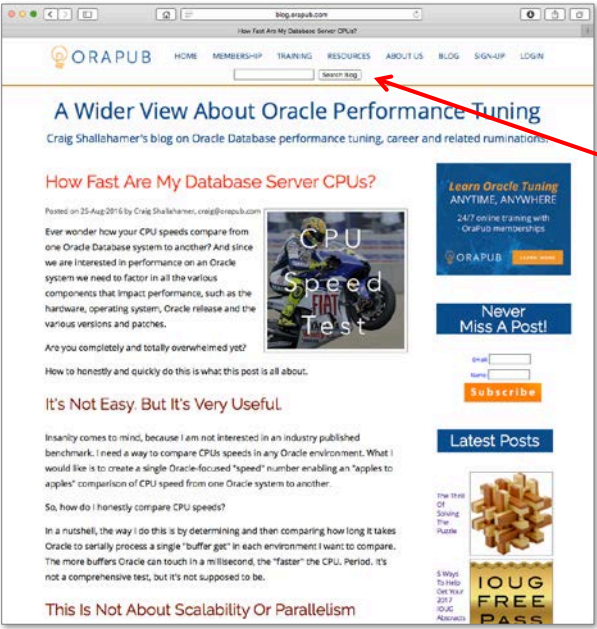


- » What will buying faster CPUs do?
- » What will buying more CPUs do?
- » What will increasing parallelism do?

What changes?  $M$ ,  $St$ ,  $\lambda$

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## A Wider View About Oracle Performance Tuning

Craig Shallahamer's blog on Oracle Database performance tuning, career and related ruminations.

### How Fast Are My Database Server CPUs?

Posted on 25-Aug-2016 by Craig Shallahamer, craig@orapub.com

Ever wonder how your CPU speeds compare from one Oracle Database system to another? And since we are interested in performance on an Oracle system we need to factor in all the various components that impact performance, such as the hardware, operating system, Oracle release and the various versions and patches.

Are you completely and totally overwhelmed yet?

How to honestly and quickly do this is what this post is all about.

#### It's Not Easy. But It's Very Useful.

Insanity comes to mind, because I am not interested in an industry published benchmark. I need a way to compare CPUs speeds in any Oracle environment. What I would like is to create a single Oracle-focused "speed" number enabling an "apples to apples" comparison of CPU speed from one Oracle system to another.

So, how do I honestly compare CPU speeds?

In a nutshell, the way I do this is by determining and then comparing how long it takes Oracle to serially process a single "buffer get" in each environment I want to compare. The more buffers Oracle can touch in a millisecond, the "faster" the CPU. Period. It's not a comprehensive test, but it's not supposed to be.

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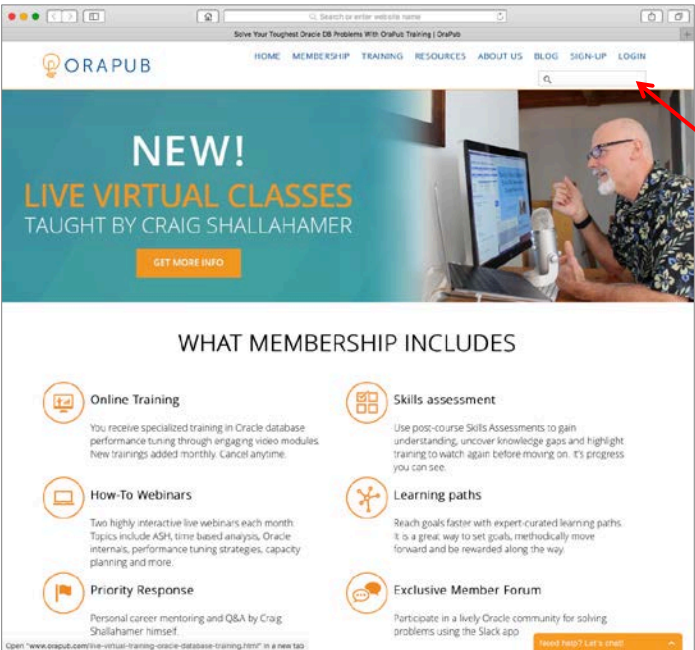
Five Ways To Solve The Puzzle

IOUG FREE PASS

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time,  
queuing,  
unit of  
work

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time,  
queuing,  
unit of  
work

## Resource listing



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  - 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](http://orapub.com)
- » **Craig's Blog & Website** – Search: "uowtba", "queue"
- » **Presentations** – Search OraPub.com: "uowtba", "queue"
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  - Forecasting Oracle Performance.

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# *Thank You!*



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