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# ORACLE Performance Tuning Workshop

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# Program Agenda

1. Performance Tuning considerations
2. Performance tuning tools
3. AWR concepts

# Performance Tuning Considerations

# Performance Tuning = ?

- To tune = (română) a ajusta
- Tuning = (română) acord fin

- **Performance tuning** is the improvement of system performance.

- Performance tuning activity:
  - Real problem (performance degradation of PRODUCTION system)
  - Anticipated problem

# Performance Tuning

- Every piece of an IT system is (could be at least) subject of performace tuning:
  - Hardware layer
  - Software layer
  - **Keep in mind: “Measurement Intrusion Effect”**

    (Malony, A. D.; Reed, D. A.; Wijshoff, H. A. G. 1992. “Performance Measurement Intrusion and Perturbation Analysis” in IEEE Transactions on Parallel and Distributed Systems, July 1992, Vol. 3, No. 4, pp. 433-450.)

- Does really exist a tuning “methodology” ?

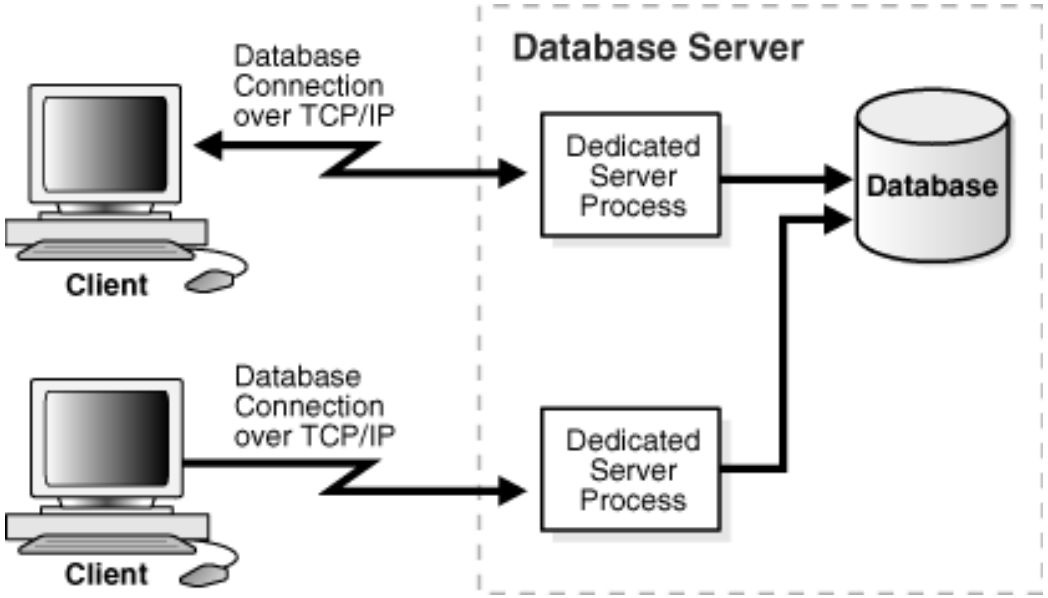
- Before starting any tuning process, establish a set of **quantifiable goals** that directly relate to a reason for tuning.

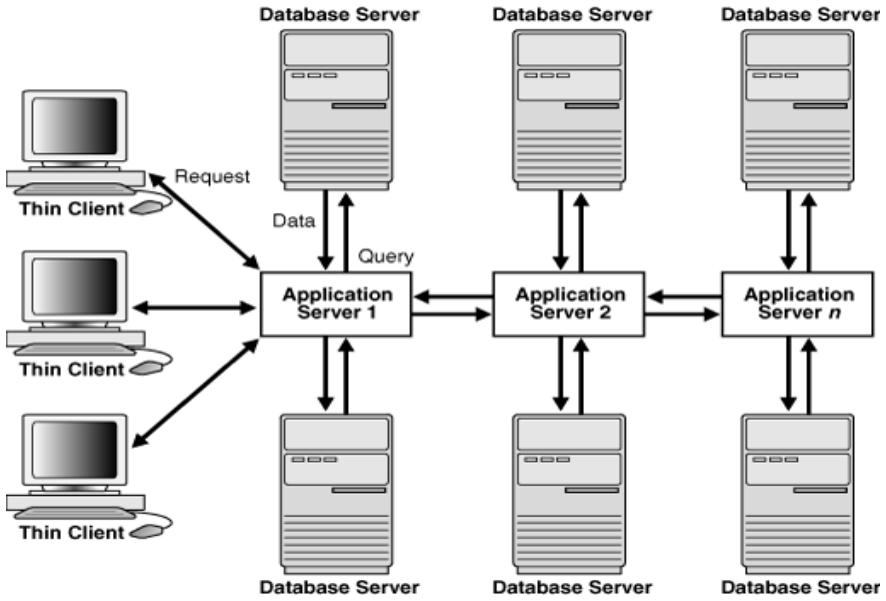
- Correct approach: tune a “workflow” instead of “database”

- **Tuning goal: appropriate resource allocation**

# Performance Tuning

- No matter what kind of architecture – identify bottleneck!
- Nowadays paradigm: **Wait time analysis**



# Performance Tuning

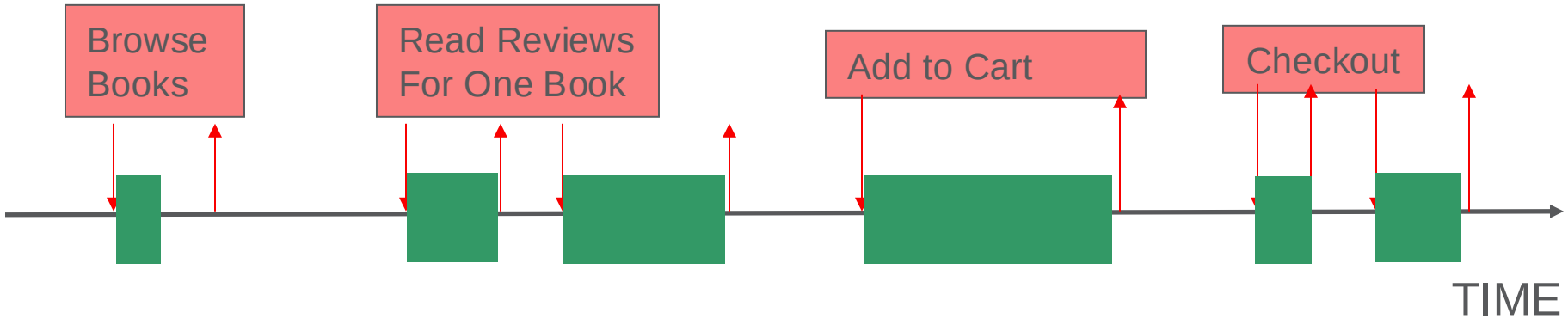
- Old paradigm – based on various ratios (such *buffer cache hit* ratio or *library cache hit* ratio)
- Modern paradigm: Wait time analysis (since Oracle version 7)
- Wait time analysis = Database **response time** tuning model

```
ResponseTime = ServiceTime + WaitTime
```

**or**

```
Response Time = CPU used + Σ TIME_WAITED
```

# A single session



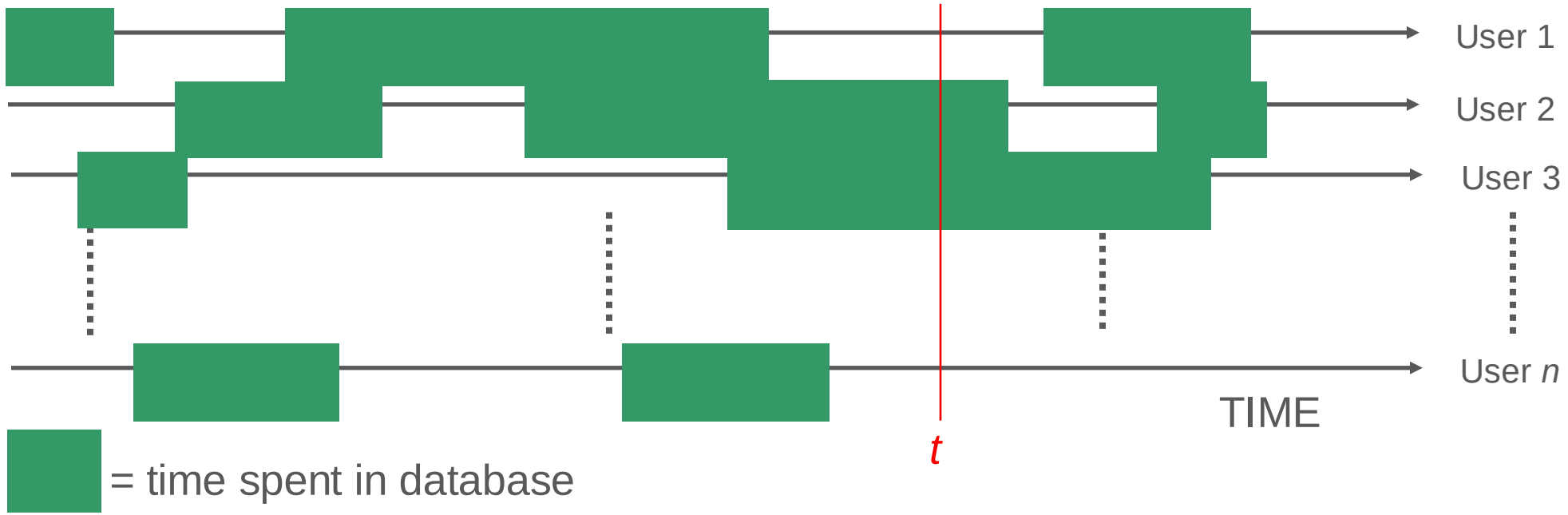

= time spent in database

rest of the time is spent outside the database (Network, Application server, etc)

# Multiple sessions

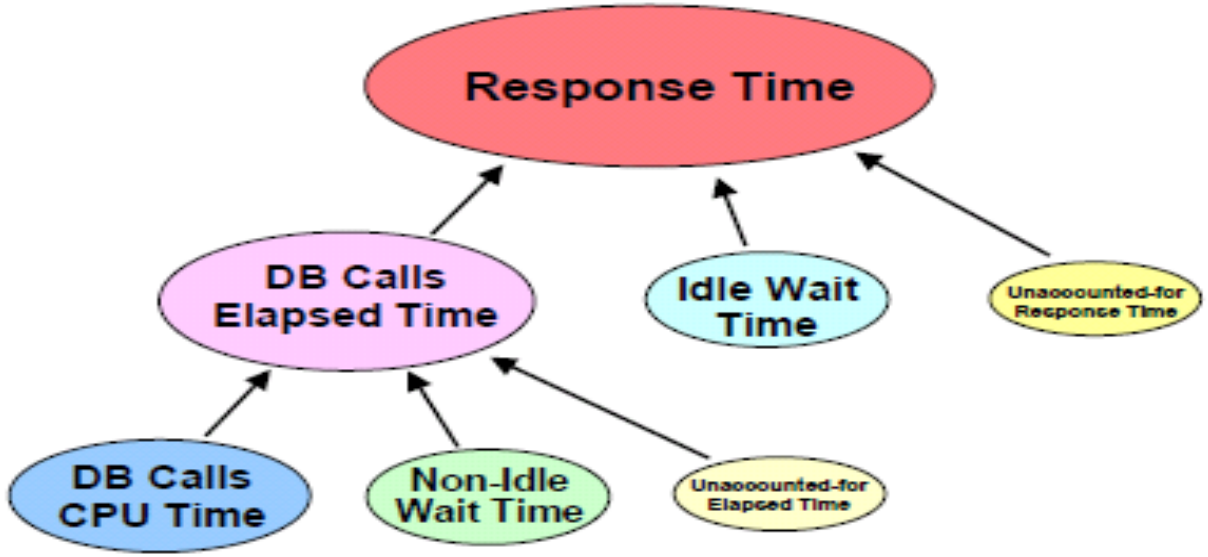
DB Time = Sum of DB Time Over All Sessions

At given time ***t*** we have 2 active sessions (sum all values)



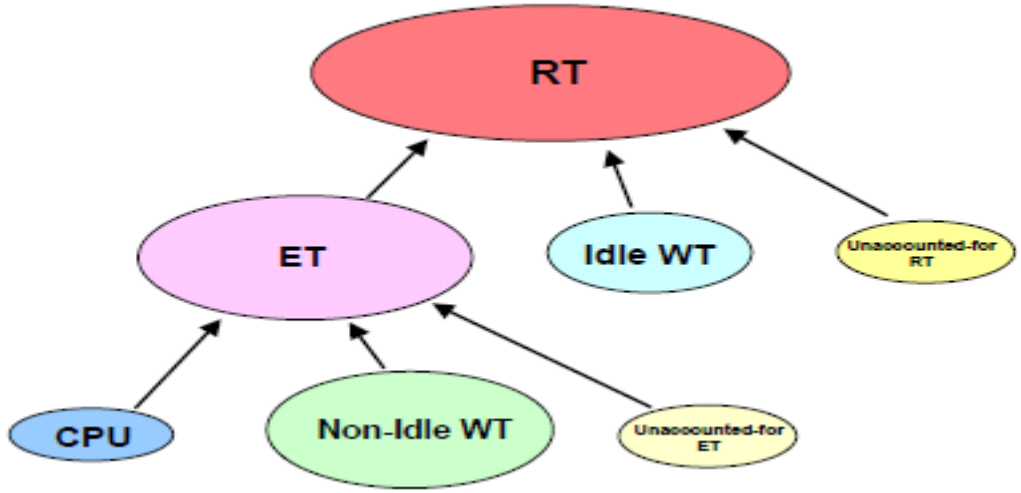
# Tuning – general considerations

## Response Time Aggregation




Area size represents the amount of time.

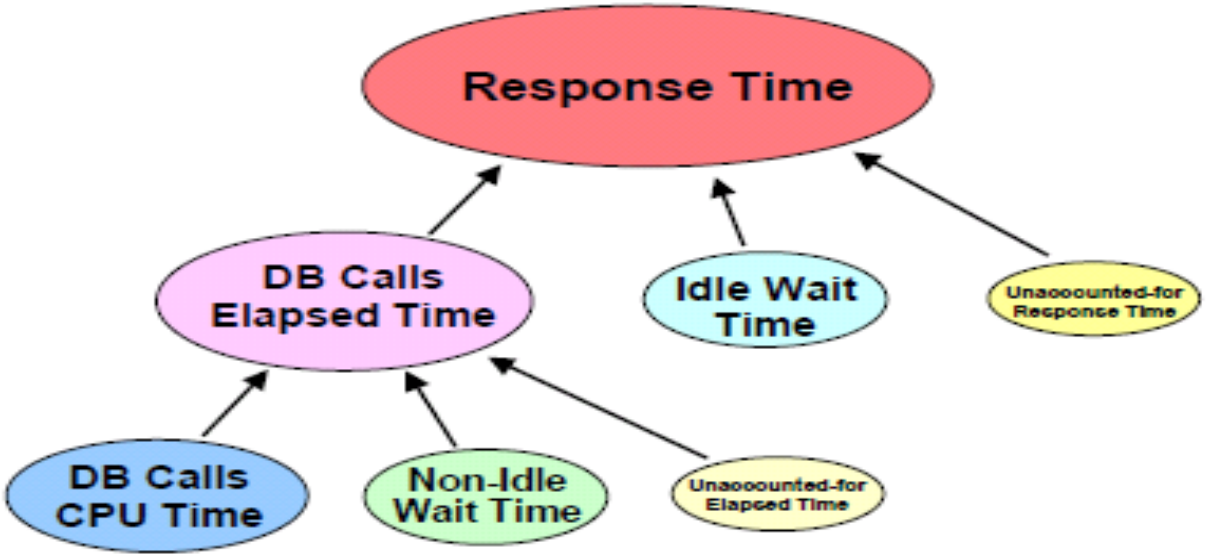
BAD. Why?




Large waits (Non-Idle events)

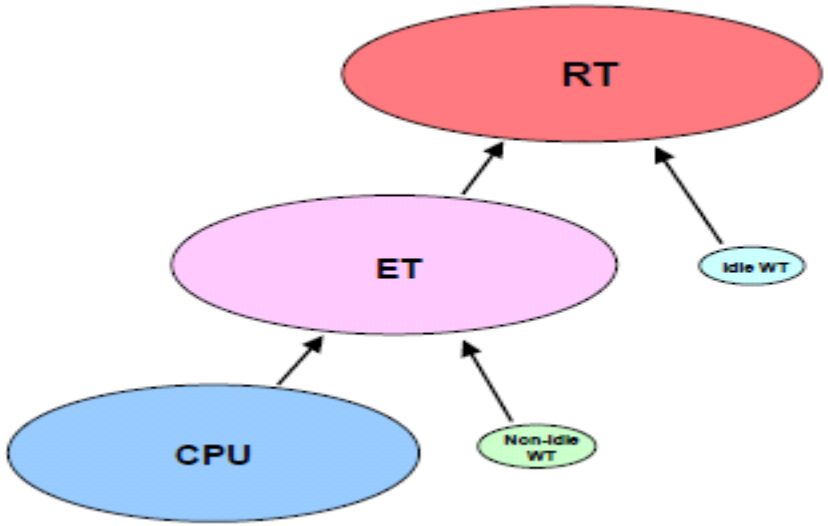
# Tuning – general considerations (cont.)

Good. Why?




Smaller Waits.

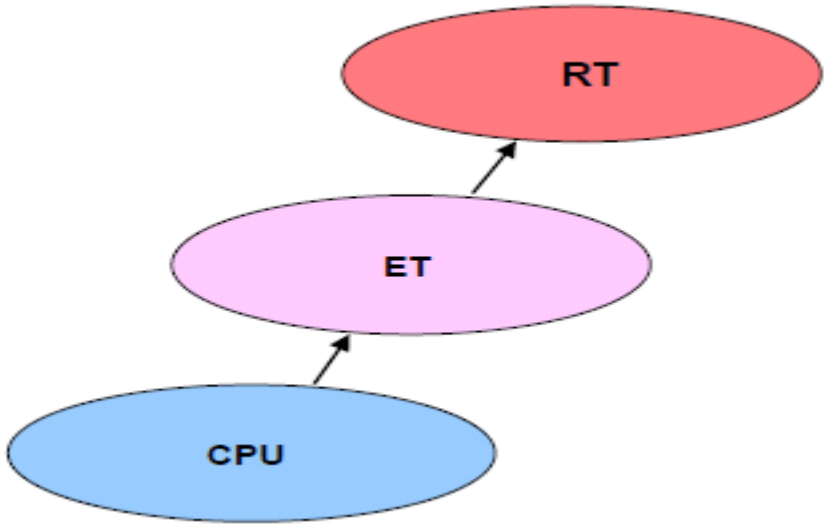
Better




Very small waits and no unaccounted-for time.
That means all time can be explained.

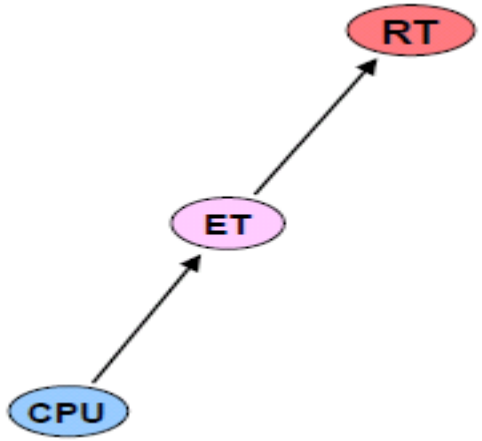
# Tuning – general considerations (cont.)

**Ideal?**




**No waits!**

**Ideal**




**No waits and small service time!**

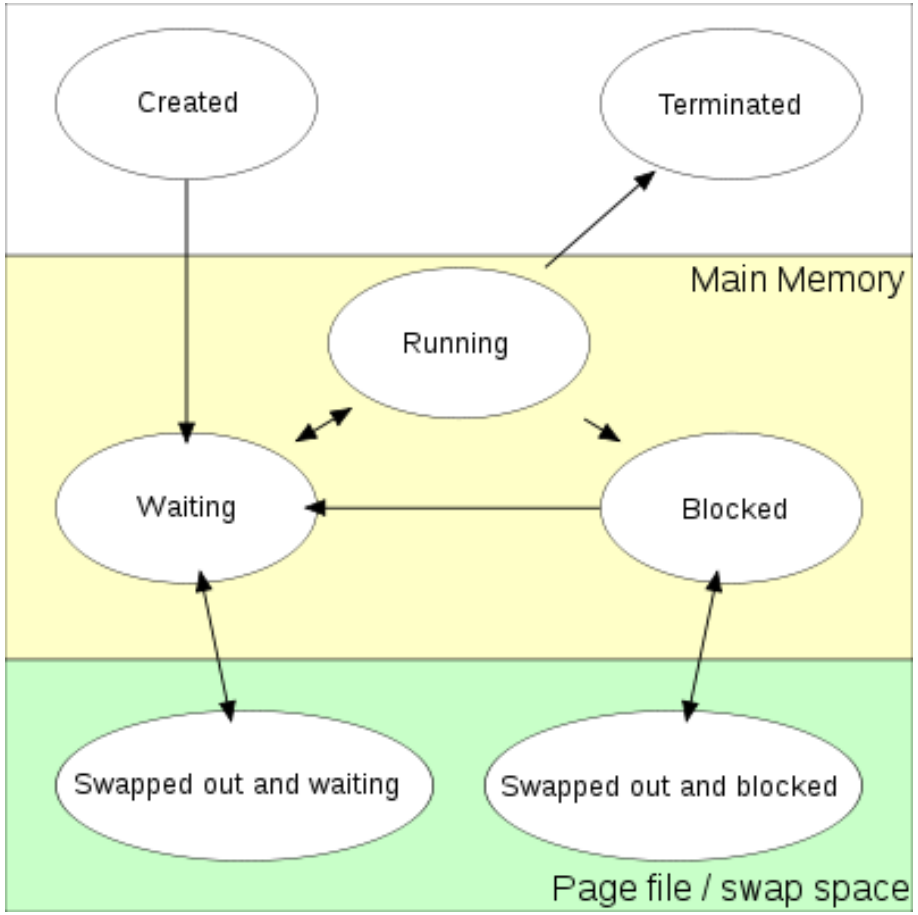
# Tools used for Oracle DB tuning

- External tools
  - Cloud/Grid/Enterprise Manager
  - OSWatcher (oswbb)
  - Various OS tools (vmstat, iostat, iotop, sar, glance, nmon, etc.)

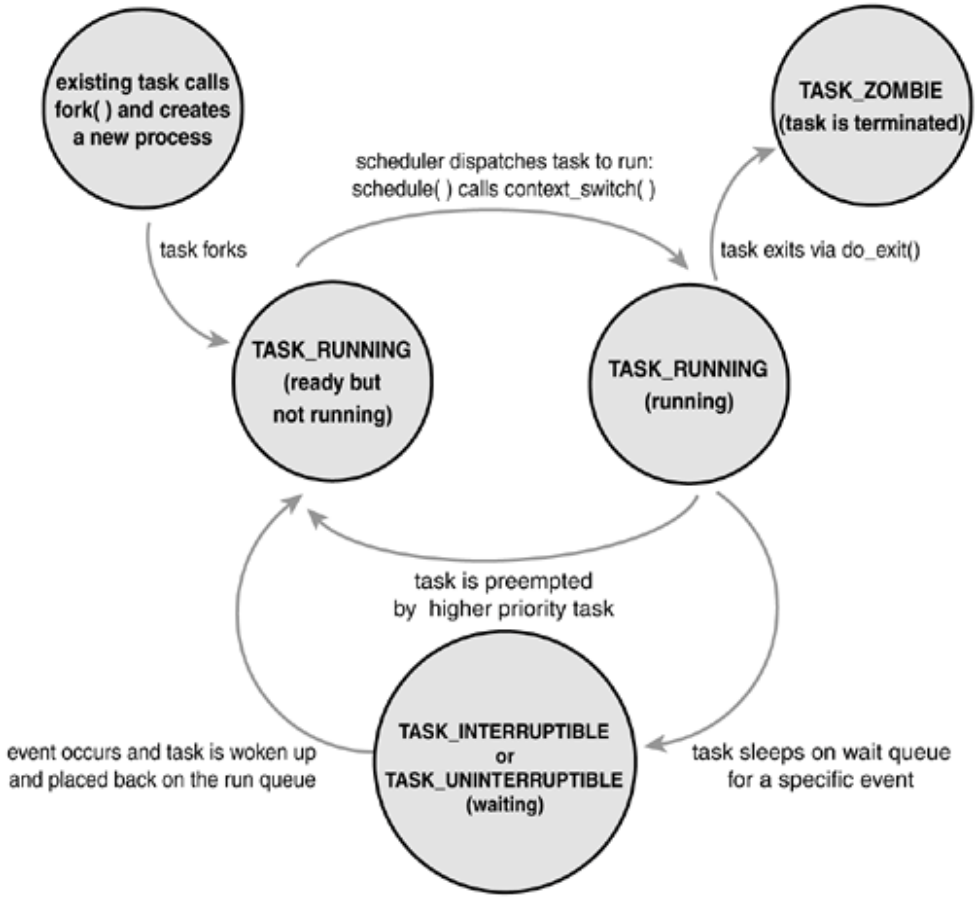
- Internal Tools
  - AWR (Automatic Workload Repository)
  - ASH (Active Session History)
  - ADDM (Automatic Database Diagnostic Monitor )

# Linux OS - process brief details

## Process state




## Process transitions



# Demo 1

# Performance Tuning Troubleshooting

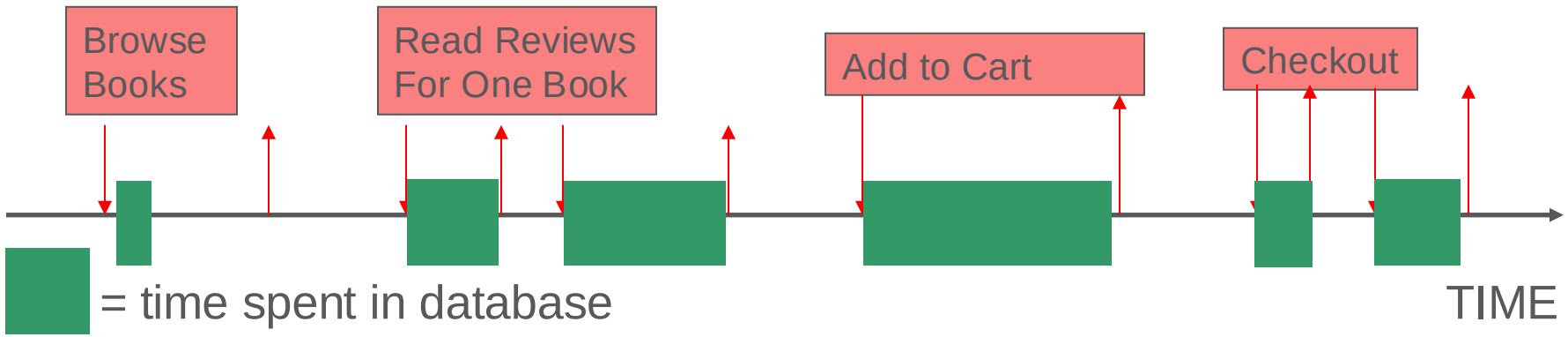
# Performance Troubleshooting

- To effectively diagnose performance problems, performance-related statistics reflecting system, sessions, individual SQL statements and database instance must be available.

- The best option is to have statistics from a representative timeframe with good performance.
  - When analyzing a performance problem, you typically look at **the change in statistics** (delta value) over the period you are interested in.

# Average active sessions

$$\text{Avg. Active Sessions} = \frac{\text{Database Time}}{\text{Wall Clock (Elapsed) Time}}$$



# Tools used for Oracle DB tuning - AWR

- Cumulative values for statistics are generally available through dynamic performance views, such as the V$SESSTAT and V$SYSSTAT views.
  - The cumulative values in dynamic views are reset when the database instance is shutdown => There is a need for a history of statistics.

- **Automatic Workload Repository (AWR)** automatically persists the cumulative and delta values for most of the statistics at all levels except the session level.
  - This process is repeated on a regular time period and creates an AWR snapshot.
  - The delta values captured by the snapshot represent the changes for each statistic over the time period.

# Tools used for Oracle DB tuning - ASH

- **ASH active session history** sampler performs the sampling.
- ASH samples the current state of all active sessions.
  - The database collects this data into memory (V$ACTIVE_SESSION_HISTORY view).
  - Active sessions are sampled every second and are stored in a circular buffer in SGA.
  - Any session that is connected to the database and is waiting for an event that does not belong to the Idle wait class is considered as an active session.
  - As part of the AWR snapshots, the content of V$ACTIVE_SESSION_HISTORY is also flushed to disk. Due to its size, only partial written to disk

# Demo 2

# AWR report

## WORKLOAD REPOSITORY report for

| DB Name | DB Id | Instance | Inst num | Startup Time | Release | RAC |
|---|---|---|---|---|---|---|
| PARIS | 4214488799 | PARIS | 1 | 28-Nov-15 13:11 | 11.2.0.3.0 | NO |

| Host Name | Platform | CPUs | Cores | Sockets | Memory (GB) |
|---|---|---|---|---|---|
| re.ro.oracle.com | Linux x86 64-bit | 2 | 2 | 1 | 5.68 |

| | Snap Id | Snap Time | Sessions | Cursors/Session |
|---|---|---|---|---|
| Begin Snap: | 117962 | 07-Dec-15 14:00:35 | 38 | 2.1 |
| End Snap: | 117963 | 07-Dec-15 15:00:46 | 41 | 2.7 |
| Elapsed: | | 60.18 (mins) | | |
| DB Time: | | 1.42 (mins) | | |

## Report Summary

### Cache Sizes

| | Begin | End | | |
|---|---|---|---|---|
| Buffer Cache: | 512M | 496M | Std Block Size: | 8K |
| Shared Pool Size: | 304M | 320M | Log Buffer: | 21,216K |

### Load Profile

| | Per Second | Per Transaction | Per Exec | Per Call |
|---|---|---|---|---|
| DB Time(s): | 0.0 | 0.1 | 0.00 | 0.02 |
| DB CPU(s): | 0.0 | 0.0 | 0.00 | 0.00 |
| Redo size: | 1,235.5 | 3,958.2 | | |
| Logical reads: | 73.3 | 234.9 | | |
| Block changes: | 5.9 | 19.0 | | |
| Physical reads: | 18.4 | 59.0 | | |
| Physical writes: | 0.5 | 1.6 | | |
| User calls: | 1.5 | 4.8 | | |
| Parses: | 1.8 | 5.7 | | |
| Hard parses: | 0.1 | 0.4 | | |
| W/A MB processed: | 0.0 | 0.1 | | |
| Logons: | 0.1 | 0.3 | | |
| Executes: | 7.2 | 23.1 | | |
| Rollbacks: | 0.0 | 0.0 | | |
| Transactions: | 0.3 | | | |

### Instance Efficiency Percentages (Target 100%)

| | | | |
|---|---|---|---|
| Buffer Nowait %: | 100.00 | Redo NoWait %: | 100.00 |
| Buffer Hit %: | 92.52 | In-memory Sort %: | 100.00 |
| Library Hit %: | 91.87 | Soft Parse %: | 93.58 |
| Execute to Parse %: | 75.52 | Latch Hit %: | 100.00 |

### Instance Efficiency Percentages (Target 100%)

| | | | |
|---|---|---|---|
| Buffer Nowait %: | 100.00 | Redo NoWait %: | 100.00 |
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| Library Hit %: | 91.87 | Soft Parse %: | 93.58 |
| Execute to Parse %: | 75.52 | Latch Hit %: | 100.00 |
| Parse CPU to Parse Elapsd %: | 43.89 | % Non-Parse CPU: | 92.03 |

### Shared Pool Statistics

| | Begin | End |
|---|---|---|
| Memory Usage %: | 69.21 | 73.24 |
| % SQL with executions>1: | 72.45 | 74.13 |
| % Memory for SQL w/exec>1: | 62.13 | 73.59 |

### Top 5 Timed Foreground Events

| Event | Waits | Time(s) | Avg wait (ms) | % DB time | Wait Class |
|---|---|---|---|---|---|
| direct path read | 865 | 21 | 24 | 24.25 | User I/O |
| control file sequential read | 1,690 | 15 | 9 | 17.76 | System I/O |
| db file sequential read | 422 | 15 | 35 | 17.29 | User I/O |
| log file sync | 155 | 14 | 88 | 16.07 | Commit |
| DB CPU | | 12 | | 14.28 | |

### Host CPU (CPUs: 2 Cores: 2 Sockets: 1)

| Load Average Begin | Load Average End | %User | %System | %WIO | %Idle |
|---|---|---|---|---|---|
| 0.08 | 1.55 | 13.8 | 0.6 | 33.5 | 85.5 |

### Instance CPU

| %Total CPU | %Busy CPU | %DB time waiting for CPU (Resource Manager) |
|---|---|---|
| 0.3 | 2.0 | 0.0 |

### Memory Statistics

| | Begin | End |
|---|---|---|
| Host Mem (MB): | 5,819.3 | 5,819.3 |
| SGA use (MB): | 1,008.0 | 1,008.0 |
| PGA use (MB): | 162.6 | 178.7 |
| % Host Mem used for SGA+PGA: | 20.12 | 20.39 |

## Main Report

# AWR analysis – Time Model

## Time Model Statistics

- Total time in database user-calls (DB Time): 30983,6s
- Statistics including the word "background" measure background process time, and so do not contribute to the DB time statistic
- Ordered by % or DB time desc, Statistic name

| Statistic Name | Time (s) | % of DB Time |
|---|---|---|
| sql execute elapsed time | 25,642.53 | 82.76 |
| DB CPU | 10,892.75 | 35.16 |
| parse time elapsed | 1,961.69 | 6.33 |
| hard parse elapsed time | 1,138.48 | 3.67 |
| sequence load elapsed time | 341.75 | 1.10 |
| connection management call elapsed time | 209.93 | 0.68 |
| PL/SQL execution elapsed time | 52.20 | 0.17 |
| repeated bind elapsed time | 14.80 | 0.05 |
| hard parse (sharing criteria) elapsed time | 8.25 | 0.03 |
| hard parse (bind mismatch) elapsed time | 1.20 | 0.00 |
| PL/SQL compilation elapsed time | 0.66 | 0.00 |
| failed parse elapsed time | 0.27 | 0.00 |
| DB time | 30,983.61 | |
| background elapsed time | 964.13 | |
| background cpu time | 229.94 | |

- Time spent in the database by operation type, based on Time (% DB time).
- The most important of the time model statistics is **DB Time**.
- Any timed operation will be buffered for at most 5 seconds of time data in 10g and 1 second in 11g.
- Not all the statistics from DBA_HIST_SYS_TIME_MODEL are displayed in AWR report TIME MODEL STATISTICS section.
- Background process elapsed times and CPU consumption aren't included in DB Time.

# Performance investigation with ASH

## Top Events

- Top User Events
- Top Background Events
- Top Event P1/P2/P3 Values

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## Top User Events

| Event | Event Class | % Event | Avg Active Sessions |
|---|---|---|---|
| CPU + Wait for CPU | CPU | 66.67 | 1.98 |
| db file sequential read | User I/O | 11.86 | 0.35 |
| read by other session | User I/O | 5.88 | 0.18 |
| SQL*Net more data from client | Network | 3.27 | 0.10 |
| log file sync | Commit | 1.96 | 0.06 |

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## Top Background Events

| Event | Event Class | % Activity | Avg Active Sessions |
|---|---|---|---|
| log file parallel write | System I/O | 5.98 | 0.18 |
| db file parallel write | System I/O | 1.21 | 0.04 |

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## Top Event P1/P2/P3 Values

| Event | % Event | P1 Value, P2 Value, P3 Value | % Activity | Parameter 1 | Parameter 2 | Parameter 3 |
|---|---|---|---|---|---|---|
| db file sequential read | 11.86 | "1","63945","1" | 0.09 | file# | block# | blocks |
| log file parallel write | 5.98 | "1","2","1" | 1.40 | files | blocks | requests |
| read by other session | 5.88 | "6","230534","1" | 0.09 | file# | block# | class# |
| SQL*Net more data from client | 3.27 | "1952673792","4","0" | 1.68 | driver id | #bytes | NOT DEFINED |
| | | "1952673792","3","0" | 1.31 | | | |
| log file sync | 1.96 | "889","744137830","0" | 0.09 | buffer# | sync scn | NOT DEFINED |

- Useful information for performance troubleshooting.

- Analysis of time spent in database by many different dimensions:

  - top timed events taking most DB time including P1,P2,P2 values that provide valuable information in determining the cause of the problem.

# Performance investigation with ASH

## Top SQL

- Top SQL with Top Events
- Top SQL with Top Row Sources
- Top SQL using literals
- Top Parsing Module/Action
- Complete List of SQL Text

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### Top SQL with Top Events

| SQL ID | Planhash | Sampled # of Executions | % Activity | Event | % Event | Top Row Source | % RwSrc | SQL Text |
|---|---|---|---|---|---|---|---|---|
| 1scvb5uvatv7u | 1726644916 | 6 | 9.43 | CPU + Wait for CPU | 3.55 | INDEX - RANGE SCAN | 0.65 | INSERT INTO RPT_STATISTICHEPRE... |
| | | | | db file sequential read | 3.08 | TABLE ACCESS - BY INDEX ROWID | 1.49 | |
| | | | | read by other session | 2.71 | TABLE ACCESS - BY INDEX ROWID | 1.21 | |
| dnnvqzyxfbpzk | 2028366371 | 4 | 8.50 | db file sequential read | 3.64 | TABLE ACCESS - BY INDEX ROWID | 1.49 | INSERT INTO RPT_STATISTICHEPRE... |
| | | | | read by other session | 3.17 | TABLE ACCESS - BY INDEX ROWID | 1.31 | |
| | | | | CPU + Wait for CPU | 1.59 | INDEX - RANGE SCAN | 0.37 | |
| fkb8xtt6adv8n | 1573011396 | 24 | 2.71 | CPU + Wait for CPU | 2.71 | SELECT STATEMENT | 1.40 | SELECT F.FRM_STIME, TO_NUMBER ... |
| 6amzjwtc5wt00 | 3504680521 | 1 | 1.77 | db file sequential read | 1.21 | TABLE ACCESS - BY INDEX ROWID | 0.93 | select * from "CDG"."PRESTAZIO... |
| 8jtqsv7q6q7ab | 105213180 | 18 | 1.68 | CPU + Wait for CPU | 1.68 | SORT - ORDER BY | 1.40 | SELECT DISP.*, GPV3SERVER.CHEC... |

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### Top SQL with Top Row Sources

| SQL ID | PlanHash | Sampled # of Executions | % Activity | Row Source | % RwSrc | Top Event | % Event | SQL Text |
|---|---|---|---|---|---|---|---|---|
| 1scvb5uvatv7u | 1726644916 | 6 | 9.43 | TABLE ACCESS - BY INDEX ROWID | 3.08 | db file sequential read | 1.49 | INSERT INTO RPT_STATISTICHEPRE... |
| | | | | TABLE ACCESS - BY INDEX ROWID | 1.96 | read by other session | 0.84 | |
| dnnvqzyxfbpzk | 2028366371 | 4 | 8.50 | TABLE ACCESS - BY INDEX ROWID | 3.08 | db file sequential read | 1.49 | INSERT INTO RPT_STATISTICHEPRE... |
| | | | | TABLE ACCESS - BY INDEX ROWID | 2.24 | read by other session | 1.31 | |
| | | | | INDEX - RANGE SCAN | 1.40 | db file sequential read | 0.65 | |
| fkb8xtt6adv8n | 1573011396 | 24 | 2.71 | SELECT STATEMENT | 1.40 | CPU + Wait for CPU | 1.40 | SELECT F.FRM_STIME, TO_NUMBER ... |
| 6amzjwtc5wt00 | 3504680521 | 1 | 1.77 | TABLE ACCESS - BY INDEX ROWID | 1.12 | db file sequential read | 0.93 | select * from "CDG"."PRESTAZIO... |
| 8jtqsv7q6q7ab | 105213180 | 18 | 1.68 | SORT - ORDER BY | 1.40 | CPU + Wait for CPU | 1.40 | SELECT DISP.*, GPV3SERVER.CHEC... |

- Analysis of time spent in database by many different dimensions:

  - top SQL ID and execution plan hash values responsible for top events( including CPU+ wait on CPU).

  - top SQL ID and execution plan hash values responsible for top events( including CPU+ wait on CPU) ordered by row source (execution plan ACCESS PATH) generating a specific event.

# Automatic Database Diagnostic Monitor (ADDM) report

```
Activity During the Analysis Period
-----------------------------------
Total database time was 175326 seconds.
The average number of active sessions was 97.13.

Summary of Findings
-------------------
    Description                 Active Sessions      Recommendations
                                Percent of Activity
    --------------------------  -------------------  ---------------
1   Top SQL by DB Time          40.16 | 41.34        5
2   Buffer Busy                 31.57 | 32.5         5
3   Top SQL by "Cluster" Wait   23.91 | 24.62        5
4   Top SQL By I/O              14.49 | 14.92        5
5   Commits and Rollbacks       11.03 | 11.36        2
6   Top Segments by I/O         9.87 | 10.17         4
7   Undersized SGA              6.36 | 6.55          1
8   Row Lock Waits              5.68 | 5.85          2
9   Index Block Split           5.19 | 5.34          0
10  Interconnect Buffer Busy    3.32 | 3.42          1

 Finding 1: Top SQL by DB Time
 Impact is 40.16 active sessions, 41.34% of total activity.
 ----------------------------------------------------------
 SQL statements consuming significant database time were found.

    Recommendation 1: SQL Tuning
    Estimated benefit is 9.55 active sessions, 9.83% of total activity.
    -------------------------------------------------------------------
    Action
       Tune the PL/SQL block with SQL_ID "0gnyyft9krgqh". Refer to the "Tuning
       PL/SQL Applications" chapter of Oracle's "PL/SQL User's Guide and
       Reference".
       Related Object
          SQL statement with SQL_ID 0gnyyft9krgqh.
          BEGIN :1 := AAA_PROCESS_DIAMETER_PS_2(: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);END;
    Rationale
       SQL statement with SQL_ID "0gnyyft9krgqh" was executed 478253 times and
       had an average elapsed time of 0.036 seconds.

    Recommendation 2: SQL Tuning
    Estimated benefit is 7.61 active sessions, 7.84% of total activity.
    -------------------------------------------------------------------
    Action
       Investigate the SQL statement with SQL_ID "cj7hn7xtzzfvm" for possible
       performance improvements.
       Related Object
          SQL statement with SQL_ID cj7hn7xtzzfvm.
          SELECT Last_Run_Date FROM T_Process_Interlock WHERE job_key = :1  FOR
          UPDATE WAIT 10
    Rationale
       SQL statement with SQL_ID "cj7hn7xtzzfvm" was executed 4364 times and
       had an average elapsed time of 3.1 seconds.
```

- $ORACLE_HOME/rdbms/admin/addmrpt.sql script runs ADDM analysis on a pair of AWR snapshots taken by the current instance and displays the textual ADDM report.

- $ORACLE_HOME/rdbms/admin/addmrpti.sql – runs ADDM analysis on a pair of AWR snapshots taken on a DBID and instance_number provided by user, available in AWR and displays the textual ADDM report.

# Useful links

- http://www.oracle.com – Oracle Web site
- http://docs.oracle.com – Oracle official documentation
- http://download.oracle.com – download Oracle products

- Browse Oracle 19c documentation
  - https://docs.oracle.com/en/database/oracle/oracle-database/19/books.html
- Download Oracle 19c documentation
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  - Windows: https://www.oracle.com/webapps/redirect/signon?nexturl=https://download.oracle.com/otn/nt/oracle19c/193000/WINDOWS.X64_193000_db_home.zip

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